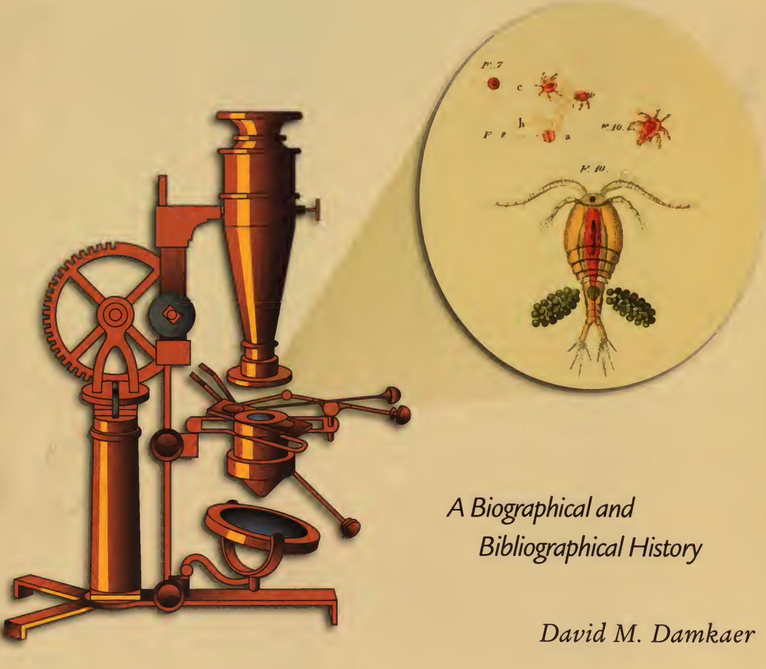
THE COPEPODOLOGIST'S CABINET



A Biographical and Bibliographical History

David M. Damkaer

THE COPEPODOLOGIST'S CABINET

A Biographical and Bibliographical History

David M. Damkaer

Copepod crustaceans are the most numerous multicellular animals on earth. They occur in every free-living and parasitic aquatic niche. Copepods have been known since the time of Aristotle, yet there has never been a history of the study of copepods. This volume, the first in a planned three-volume series, reviews the discoveries of copepods to 1832, the year that the two distinct branches—the free-living copepods (long-known as insects) and the parasitic copepods (thought to be molluscs or worms), were finally acknowledged as members of the same Class Crustacea. The narrative includes the biographies of 90 early copepodologists and recounts their most important contributions to science. Portraits are included for two-thirds of the subjects, with significant new material as well as information and illustrations from obscure sources.

Milestones include the first description of copepods (ca. 350 B.C.), the first illustration (1554), the first free-living freshwater copepod (1688), the first explanation of a free-living copepod's metamorphosis (1756), the first permanently named copepod (1758), the first free-living marine copepod (1770), and the first description of a parasitic copepod's metamorphosis (1819). The work ends with a transition to the mid-19th century, previewing numerous personal connections that pointed toward copepodology's Golden Age in the 1890s, to be covered in Volume 2. A final volume will take the history of the study of copepods to ca. 1950.

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THE
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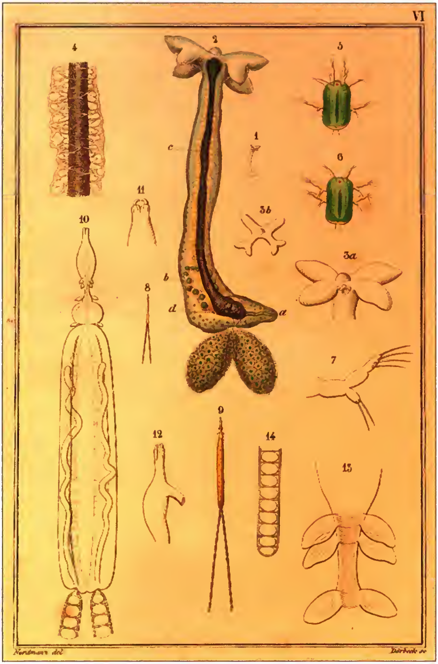
Not to prayse or disprayse: all did well.
—William Harvey
Canones Anatomiae Generalis



A common parasite of European freshwater fishes, Lernaea cyprinacea *Linnaeus, 1758 (Figs. 1–7) preserves the oldest valid copepod name. This plate, from Nordmann (1832), with Figure 1 of natural size, illustrated for the first time the parasite's free-living "nauplius" stages (Figs. 5–6), proving the crustacean status of this age-long puzzle. A second species,* Peniculus fistula *(Figs. 8–14), parasitic on a Neapolitan marine fish, was first described by Nordmann. Its natural size is indicated by Figure 8.*

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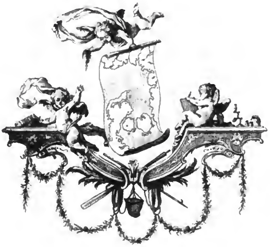

AMERICAN PHILOSOPHICAL SOCIETY
Philadelphia, Pennsylvania

Memoirs
of the American Philosophical Society
Held at Philadelphia
For Promoting Useful Knowledge
Volume 240

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Memoirs series, Volume 240. All rights reserved.

ISBN: 0-87169-240-6
US ISSN: 00659738

Library of Congress Cataloging in Publication Data

Damkaer, David M.
The copepodologist's cabinet: a biographical and bibliographical history / David M. Damkaer
p. cm. — (Memoirs of the American Philosophical Society held at Philadelphia
for promoting useful knowledge; vol.240)
ISBN 0-87169-240-6 (cloth)
1. Copepoda—Research—History. I. Title. II. Memoirs of the American Philosophical Society; v. 240.
Q11 .P612 vol.240
[QL444.C7]
081 s—dc21
[595.3'4'09] 2002045794

VOLUME ONE

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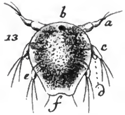
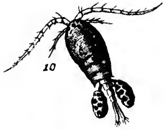
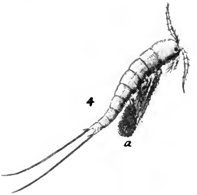
Aristotle to Alexander von Nordmann
(330 B.C. to A.D. 1832)





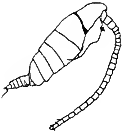


MANY OF THESE NOTES are devoted to notices of the individuals who, so far as I could learn, were the first to notice the species . . . to which their names are respectively affixed. . . . This has been a pleasing inquiry. Smit with the beauty—real or fancied—of the objects of his study, a curiosity is naturally awakened to discover the name and degree of the person who had first deemed it worthy of his examination and participated in our pleasure, for we conclude assuredly that he who had taken the trouble to record the name and treasure up the object, was one of like mind, and imbued with much the same affections and dispositions as ourselves. Some of them were found to be men of renown, others, in whom I felt a deeper sympathy, are now forgotten, their name and their labours swallowed up in the higher and more enduring reputation of those whom they were honoured to assist and delighted to serve. The genuine naturalist will not censure this "fond attempt" to restore the faint traces of men who had sought the best occupation of a leisure hour in congenial pursuits and studies; but rather will with me lament the obscurity and shortness of their "simple annals."

—George Johnston
A History of the British Zoophytes

IT IS NOT FOR ME, or any other living man, to design or paint the scenery or to dress the players or even to clap or hiss their exits and their entrances. I can but strive to discharge with fidelity the humbler office of the man who manipulates the limelight—whose duty is to show, in just illumination, the performers in a drama which I neither did nor ever could compose, and of whose intricate plot I have but the roughest working knowledge.

—Clifford Dobbell
Antony van Leeuwenhoek and His "Little Animals"



To Gayle Ann Heron

my teacher, my colleague, my very close friend,
with gratitude, respect, and affection.
This book is hers, too.

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Most vignettes are from Bate and Westwood (1863, 1868). The deepsea angler fish is from Marshall (1954, dust jacket); the device of the Swedish Academy of Sciences (Chapter 5) and the letterhead of the French Academy of Sciences (Chapter 9) are from Lindroth (1967b); the gentlemen in the French natural history cabinet (Chapter 9) are from Cap (1854).

This vignette represents an incident in the pursuit of science that befell one of the authors near the Lizard Point, Cornwall.

PROLOGUE

As it is the commendation of a good huntsman
to find game in a wide wood, so it is no
imputation if he hath not caught all.
—PLATO, *Dialogues*

THE READER very likely is acquainted with numerous little copepods and appreciates their celebrated role on the aquatic stage. For those who need some reminding, I have included several defining points in the Introduction.

Normally a zoologist's interest is in the first two parts of an organism's complete scientific name; for example, *Calanus finmarchicus* (Gunnerus, 1770). This terminology tells us much: (1) the animal is of the species *finmarchicus* and is distinct from all other species of the world—in an ideal case, the original description of this species would be linked objectively to a type specimen deposited by the first investigator in an appropriate museum (this particular example also indicates that the species is "from Finmark," although accessory information is not a requirement of specific names and could even be misleading); (2) the animal belongs in the genus *Calanus,* which indicates obvious but subjective relationships to other species of that genus; (3) the species, as a distinct species, for it may have been described first as an indistinct oddity, was first named and described by someone named Gunnerus; (4) that Gunnerus offered his description to the world by publication in 1770; and finally, (5) that in spite of Gunnerus placing his new species in one genus (this happened to be the old Linnaean genus *Monoculus*), the species *finmarchicus* has in the meantime been assigned by subsequent publication to a different genus, in this case *Calanus* (that is the significance of the parentheses; a lack of parentheses indicates that the species remains in the genus originally assigned).

The scientific name, or binomial, and its related terminology are rigidly regulated by the International Code of Zoological Nomenclature adopted by the International Congress of Zoology. Nomenclature has always deferred to the simple philosophy that priority is given to the earliest name. We will see that this is not always as explicit as one would like. The Code had its precursors in separate countries: Great Britain (1842), America (1877), France (1881), and Germany (1894). These prevailed until the Secretary-General of the First International Congress of Zoology (Raphael Blanchard, an incidental copepodologist) proposed international rules in Paris in 1889. The rules were adopted at the Second Congress in Moscow in 1892, and they continue to be periodically evaluated and revised.

There is fundamental importance in clear species names and their judicious manipulation. It is through the species name that everyone can correctly understand to what organism a work refers. This is the key to all knowledge about that organism; it is the same key regardless of the country or language of an investigator. Without species names, it would be hard to imagine a coherent literature, or history, on copepods or any other animals. Notwithstanding this importance, this treatise looks not to the first part of a "scientific name," but to the latter part, to the author and the date, to his life and times and contributions.

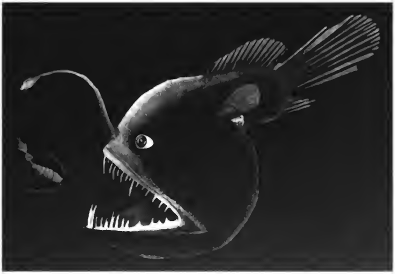
There are several good histories of the study of insects, but as for the "Insects of the Sea," a term that has been applied with some justification to copepods, there has been none. There have been many excellent general reviews of the literature, but they have seldom given information about the persons involved or their social context. I cannot give a complete bibliography of each investigator, for this would take several volumes by itself—and has been creditably done by others. For many years, my best collected references to the older copepod papers was a large manuscript prepared by C. B. Wilson, up to ca. 1940. This has now been superseded by the indispensable three-volume bibliography prepared by Vervoort (1986a,b; 1988). My intention is to specify at least the cornerstone papers and, if appropriate, add papers that have been overlooked.

A compilation useful in finding, deciphering, and dating older literature is the four-volume ***Bibliographia Zoologiae et Geologiae*** by Agassiz (1848, 1850, 1853, 1854). This lists "all the known works and detached memoirs on zoology."

This discourse is necessarily uneven due to sources: little is known about some high-ranking workers, and a great deal may be known about some who contributed little to copepodology. I am reminded of a day in the deep stacks of the library where I almost did not look at the 1927 Lingnaam (China) Agricultural Review; this underscored the fact that some copepodologists, major or minor, may have been well-known in other fields. Articles about persons (testimonials, obituary notices, etc.) are often indexed (if they are indexed at all) under the author's name rather than by the subject-person, and important information can be found just by browsing. The reader is asked to accede to the inconsistencies, which, in any case, point out that additional facts are desired.

As this labor of love is concluded, I see at once two faults: in total it is too long, but in every part it is too short and unfinished. No single book could encompass the whole biographical and bibliographical history of the study of copepods. I will always be pleased to hear about supplemental historical information. Much valuable material remains in unrecorded photographs, letters, and recollections of friends and students, as well as in truly obscure publications. Much undoubtedly survives in family archives and in manuscripts filed in institutions around the world.

I hope that you are looking forward to looking back, to an ended time and to a world that is not ours, but that had to be before we could be.



ACKNOWLEDGMENTS

I cannot fix on the hour, or the spot, or the look,
or the words, which laid the foundation. It is too long ago.
I was in the middle before I knew that I had begun.
—Jane Austen, *Pride and Prejudice*

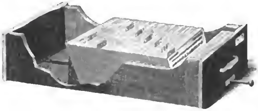
TO HISTORY! Where would we be without it? This book was begun long before my time, and I shall never see its end. Not yet at death's door, but definitely in the hallway, I want to record those things only I know, or have now that would be gained by others with difficulty. For forty years, I have acquired biographies and biographical snippets, often only by chance, in faraway places in dusty bookshops, dark libraries, and even cemeteries. But there was always the joy of discovery, and this I trust is now shared. For me it has been a pleasure to traverse by way of the old literature the dawning days and places. In contrast to other sciences, where ideas might be swept away and forgotten, taxonomy respects the oldest works through the principle of priority, and these are linked forever with the species descriptions. Nevertheless, with revisions and improved descriptions, most older works are superseded in practice, and it is not necessary to have access unless one is reviewing and revising taxonomic categories. That some workers cannot or do not refer to early works continues to confound taxonomy.

Undoubtedly, some of the monographs I have obtained during this time may never be available in another lifetime, and a few that at this moment seem beyond availability may well be acquired. It is this aspect that offers much excitement to the dedicated bibliophile. Only one who is similarly afflicted will appreciate this understatement. Regarding the availability of books (and now we must add *original* books, since there is the possibility of cheap and rapid reproduction), we at the beginning of the twenty-first century are in no worse position than earlier workers. Baird (1837), across a gulf of only seventeen years, lamented the unavailability of Jurine's classic work of 1820; there are only a few examples of this beautiful book in the United States. Robert Gurney (1931) said of Schmeil's exquisite work of 1892–1898 that it was "now unprocurable." It is doubly, or infinitely more, satisfying then to have long ago purchased a copy of the incomparable Schmeil monograph that had belonged to Gurney's brother, Eustace, complete with a handsome bookplate, and also to have found the complementary and equally precious monograph of Giesbrecht (1892) that had been owned by Robert Gurney, likewise with bookplate. It is difficult to describe the varied fascinations of original books or papers, with their grand and venerable aromas, textures, and notations. To know that this very document was likely in the hands of the author, and that it passed through the hands of one or several appreciated colleagues of former generations, brings aged knowledge as well as emotional experiences by breaching the time barrier; it also brings the responsibility of preservation.

Pre-Linnaean copepod literature, rare and difficult to access as it is, is not like that on fish, birds, mammals, insects, or plants, with many splendid and important examples. Still, there are a few references from this period. It is worth pointing out that even some of the publications from the late eighteenth or early nineteenth centuries are also very difficult to find. Some of these have not been consulted in the present review; notwithstanding, the author has lived through a period during which it has been possible to obtain, by diligent perusal of the world's second-hand natural-history book trade, a credible library related to the study of copepods. It is fitting and proper to acknowledge here with earnest gratitude the expert services of the antiquarian bookdealers. As representatives of this network, I must mention in particular Wheldon & Wesley, Bernard Quaritch, Anthony D. Lilly, Antiquariaat Junk, and Ch. de Wyngaert.

Of booksellers:

> I wonder often
> what the vintners buy
> One half so precious
> as the stuff they sell.
>
> —The *Rubaiyat* of Omar Khayyam, ca. 1120



Much good fortune has accompanied these endeavors, probably because they were begun sooner in life than is typical for histories. However, I was sadly a few steps behind the grim reaper on some occasions; on others, authors had thrown out their correspondence in old age, believing it was of no interest to anyone. There were many coincidences, both fulfilled and unfulfilled. For example, R. N. Wolfenden's son, whom I never met, died in my own town. But usually the consequences were favorable.

This treatise was compiled with gifts from many memories. My first personal debt and greatest pleasure was for the acquaintance with senior researchers who gave much assistance or who otherwise encouraged me in this effort: Jean G. Baer, E. W. Borutzky, Thomas E. Bowman, Alessandro Brian, K. A. Brodsky, Fenner Chace, Norberto Della-Croce, Peter Dohrn, Abraham Fleminger, James Fraser, Paul Galtsoff, Vagn Hansen, Alister Hardy, Dora Henry, Arthur G. Humes, Paul L. Illg, W. A. Jaschnov, Martin Johnson, Z. Kabata, Trevor Kincaid, Eugene Kozloff, Johannes Krey, Daniel Merriman, S. Motoda, Otto Pesta, F. D. Por, Alfred C. Redfield, Rupert Riedl, Waldo Schmitt, Belle A. Stevens, Takasi Tokioka, W. Vervoort, Austin Williams, M. S. Wilson, Torben Wolff, and Stillman Wright. Brothers of the Net. Years of copepods. Dusk of memory. Would that I could ask again.

Richard H. Fleming, Thomas G. Thompson, and Georg Wüst instilled an early appreciation of the history of the study of the seas.

Distance and sometimes only missed junctions kept me from meeting a number of senior workers whose contributions and support nevertheless were freely given by correspondence: Ruby Bere, Mildred Campbell, David Causey, Takuo Chiba, C. C. Davis, A. De Decker, G. B. Deevey, C. Delamare-Deboutteville, Bernard Dussart, Lela A. Ewers, Jacques Forest, Peter Gray, Albert E. Gunther, Maryvonne Hamon, J. P. Harding, L. B. Holthuis, Zbigniew Jara, Helmut Kunz, Sheina Marshall, Ernst Mayr, Theodore Monod, Helen E. Murphy, A. G. Nicholls, Wolfram Noodt, John Bennet Olson, Edward B. Reed, Frederick S. Russell, Mary Sears, Sven G. Segerstråle, Otohiko Tanaka, Jean Theodorides, Odette Tuzet, Masuzo Uéno, Tetsuo Yamada, Harry C. Yeatman, J. Z. Young, and Donald Zinn.

Much is owed to the late Thomas Saunders English, the most thoughtful and generous teacher I have known. I never left him without having learned some new thing; his personality continues to exert a great and kindly influence over my life and work. And to Joel Hedgpeth, whose many contributions to the history of marine science keep the flame burning and set a high standard: *manibus amici.* I shall always treasure our fellowship.

Special recognition must be given to families of departed copepodologists for unique and precious materials generously shared: Eugene Canu's daughter (Sabine), Friedrich and Maria Dahl's daughter (Tenge), George P. Farran's son (Chomley), Mrs. Charles J. Fish (Marie Poland Fish), Stephen Forbes's grandson and Ernest Forbes's son (Richard), Edward Foster's daughter (Mrs. Clay W. Brooks), Hermann Friedrich's son-in-law (Kurt Schmidt), Mrs. Henri Gauthier, Robert Gurney's son (Oliver), Walter Klie's son and daughter (Hermann and Gerda), Seiji Kokubo's son (Saburo), Mrs. Takamochi Mori and her niece Mary Yanokawa, Mrs. Maurice Rose, Hans Wolfgang Schäfer's daughter (Cora Schaefer Ovens), Thomas

Scott's grandson and Andrew Scott's nephew (Rowland Scott), Mrs. Sergius S. Smirnov (Nina A. Akatova), M. S. Wilson's husband (Charles S.), and R. N. Wolfenden's in-laws.

Of my own generation, crucial personal encouragement was freely given by Karl Banse, Janet Bradford-Grieve, Roger Cressey, Douglas Dey, Frank D. Ferrari, Audun Fosshagen, Bruce Frost, Jack Greenwood, Louis A. Hobson, Conrad Mahnken, J. B. L. Matthews, Harding B. Michel, Makoto Omori, Shigeko Ooishi, Kenneth Sherman, V. S. Shuvalov, Jože Štirn, and Julio Vidal. And by correspondence, Kraig Adler, Tagea Bjornberg, Roland Bourdon, Chen Qing Chao, Margaret Deacon, Frank Fiers, Christiane Groeben, Hans G. Hansson, Keith Harrison, K. Hulsemann, Rafael Lemaitre, E. L. Markhaseva, Eric Mills, T. Onbé, Inacia de Paiva, Nancy A. Rayner, Anthony Rice, H. S. J. Roe, J. C. von Vaupel-Klein, and Chad Walter.

I cannot overlook the essential services of librarians and curators as a class, and especially those at the University of Washington, the Smithsonian Institution, and the Marine Biological Laboratory (Woods Hole) where I have spent substantial time, with enormous benefits, following copepod tracts and tracks. Jacqueline Carpine-Lancre, Bibliothèque, Musée Océanographique, Monaco, provided much personal encouragement and a comprehensive array of obscure documents and publications concerning French copepodologists. Jacqueline Bonnemains, Curator, Lesueur Collection at the Museum d'Histoire Naturelle, Ville du Havre, and Fanny Audous provided unique material on Suriray and Lesueur. Volker Mahnert, Director, Geneva Museum of Natural History, contributed critical publications about François Mayor. H. John Symons, The Wellcome Institute for the History of Medicine, London, contributed details about some of the many early workers who were also medical men. Dr. L. B. Holthuis and Dr. W. Vervoort of the Nationaal Natuurhistorisch Museum have served as archivists extraordinary, providing rare texts from the treasures of Leiden and Amsterdam.

Dr. Z. Kabata, Pacific Biological Station, Nanaimo, aided and abetted my passion through the magic of e-mail and countless discerning letters. C. W. P. Mac Arthur opened the door on Delaroche and Mayor. Frank Ferrari sent copies of biographical items I had overlooked during my years at the National Museum. My cousins, Julie Lundberg Alden (California Academy of Sciences) and Bengt A. Lindskoug (Malmö, Sweden) cheerfully rose to occasions when I was thwarted in literature retrieval.

Sharon Ann Damkaer and her doggies, both real and otherwise, have been the light of my life for twenty years.

For lifelong selflessness, honor goes to Carl Christian Damkaer and Mildred Lindskoug Damkaer, who had faith in their sons and in the book that they will never see.

Two unknown cornea donors gave me a second gift of sight in 1994; they will live again whenever they are remembered.

INTRODUCTION

In Nature nothing is insignificant, nothing ignoble,
nothing sinful, nothing repetitious. All the music
is great music, all the lines have meaning.
—Donald Culross Peattie, *Green Laurels*

COPEPODS are aquatic: no water, no copepods—it is the law. Unlike their insect analogs, copepods have never forced themselves on us. No one was ever stung by a copepod; no book or tree ever eaten by a copepod. (Parasitism of man indirectly by way of copepods was not discovered until late in the nineteenth century.) Terrestrial man has never yet been visited by a plague of copepods. Yet these small crustaceans have always been part of our encircling world.

It is easy to imagine that copepods and mankind first crossed paths among the earliest fishermen. The relatively large copepod parasites commonly infesting freshwater and saltwater fish must have been noticed, and they probably were called the equivalent of "fish-lice" or "sea-lice," in comparison to pests that the fishermen themselves hosted. Indeed, the lice epithet has come down to our present day.

Man's first encounter with a free-living copepod was undoubtedly also in the distant misty past. Unsung and unrecorded, a glint of sunshine on a spinning speck in a grassy pool caught the eye of a distracted hominid. A rough hand probably brought him or her back to reality, to make history of a different kind. This comes to mind because of what I remember as a boy watching, wondering, and in my happy case, finding out.

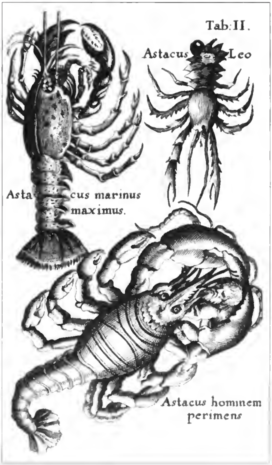
Crustaceans

"Crustacea" is a Latin word of long standing. In its simplest sense crustaceans are the animals with a crust, a semiflexible covering distinct from the rock-hard shell of mollusks.

Everyone has some familiarity with Crustacea: we eat lobsters, shrimp, and crabs. Yet some may still be surprised to learn that barnacles are crustaceans, and so are the numerous "sand fleas" that are to a beach what ants are to a meadow picnic. Likewise, the ubiquitous "pill bugs" chewing seedlings in our gardens are crustaceans, not bugs. Recognition of some crustaceans, crabs for instance, goes back farther than written history. The ancient Babylonians placed cancer, the crab, in the constellations, as did the later Greek and other societies. But by far the greater number of crustaceans have always lived their lives outside of man's experience and so have been ignored.

There was little literature on crustaceans in the classical period, in spite of the Latin heritage; this was especially true for the smaller forms (Stebbing 1893). As with knowledge of conspicuous animals, the scientific value of the ancient literature on crustaceans was essentially sterile and filled with scholarly ignorance, myth, and misunderstanding. Then, as now, writers tended toward the sensational, believing that they would spark greater interest with the largest animals. Centuries-old myths led to well-entrenched and fabulous tales, such as Olaus Magnus's report in 1555 of a lobster from northern waters that was so big and strong that it could catch and devour a man. The last gasps of such legends were seen in the early 1800s in the summaries of Louis A. G. Bosc, a well-educated and eminent French naturalist, who will be discussed in more detail later. Bosc and his revisors held to the fable that Sir Francis Drake was killed and eaten by giant crabs in the West Indies. Although Drake did die in the Indies, it was he and his men who ate the crabs, not the other way around. In spite of medieval myths of man-eating lobsters and crabs, even the largest of these is no grave threat.

In the twenty-one hundred years from Aristotle to Linnaeus, both of whom we shall address shortly, the good and bad contributors to our understanding of all types of crustaceans numbered only a few hundred (Calman 1911). During this long period, after a credible start with Aristotle, natural history slowly turned from fabrication and conjecture, through observation, study, and some experimentation, to the methodical classification of collections and individual specimens, and to the solid building of the foundations of a science. It was the Swedish naturalist Carl Linnaeus who introduced the binomial system to biology, giving every known organism a genus and species name, that brought order from the long preceding confusion. For zoology as a proper science, this system is agreed to have begun with Linnaeus's tenth edition of his *Systema Naturae* in 1758, and by convention all previous work can be ignored with respect to its taxonomic value. However, there is historical interest in the sparse and indistinct pre-Linnaean literature. With the *Systema Naturae,* the stage was then set for the magnificent achievements that quickly followed Linnaeus's pioneer work.


Tab: II.
Astacus Leo
Astacus marinus maximus.
Astacus hominem perimens

Eyewitness account of "the lobster that can kill a man" and other large crustaceans, residues of medieval fantasy. From Sachs (1665).

* * *

The majority of Crustacea undergo after hatching at least some metamorphosis, changing from larval stages to the adult form. This metamorphosis was first described in 1756, for a free-living copepod, by a Danish physician, Johan Lange. Shortly afterward, in 1769, Martin Slabber, a Dutch naturalist, made similar revelations about the closely related cladocerans. The earliest observations on metamorphosis were overlooked or misunderstood for a very long time and required many confirmations. John Vaughan Thompson's (1830) now-famous findings of the affinity of barnacles to crustaceans, rather than mollusks, as indicated by their metamorphosis, were every bit as surprising as the parentage of some parasitic copepods, hitherto believed to be "zoophytes," a catchall group of puzzling "animal-plants"—it would be impossible to conclude from their adult form that these zoophytes were copepods, or even crustaceans. This knowledge was not embraced by mainstream natural history until the authoritative work of Alexander von Nordmann (1832). These disclosures, to which we will return, were much disputed at the time. It is remarkable that such an interesting principle, that of relationship revealed by development, should have been neglected for so long, and when finally validated would be so hotly contested.

By the end of the 1800s, the investigations of natural history in all its forms—aided by improvements in the microscope, the broadened opportunities for marine studies, and the zeal accompanying studies related to the origin of species—reached an incredible quantity and quality.

To relate what was known of crustaceans around 1700 to what was known of them by 1900, one can look to Linnaeus's first edition *Systema Naturae* in 1735, where the entire class was encompassed in a few lines. Linnaeus's expanding "System of Nature" commanded only fifty-three pages for crustaceans by its thirteenth and last edition in 1788. The French biologist Anselme Desmarest included everything worthy of crustaceans in a single 1825 volume. By 1840, his countryman Henri Milne Edwards's classic "Natural History of the Crustacea" amplified that threefold, becoming the first truly useful treatise on Crustacea. Detailed information was rapidly compiled after that time; for example, one comprehensive study, the *Challenger Reports* from the 1880s, required four thousand pages and over six hundred plates to describe the crustaceans collected on the world-encircling *Challenger* Expedition. Of course, information on the smaller crustaceans paralleled the expanding knowledge of crustaceans in general, and by the mid-1800s there were substantial monographs dedicated solely to copepods, by that time a subscience in itself, copepodology.

Copepods

In between the disparate groups of Crustacea lie the tiny copepods, by the thousands, with a great diversity of structure and habits, and playing key roles in what once was termed "the economy of nature." More fish and other aquatic animals, including the largest whales, feed on copepods than on any other animal group. The strange name "copepod" is from Greek, meaning "oar-footed" or "paddle-footed," and dates from 1830. The historical progression of the study of the oar-footed crustaceans is the subject of this treatise.

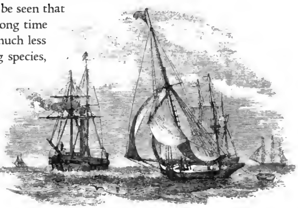
An excellent introduction to copepods, followed by extensive specialist information on their classification and structure, and their evolution into numerous ecological niches, is available in Huys and Boxshall (1991).

If you tow a fine-meshed net on the surface of lake or sea and empty the contents into a glass jar, you can find many lively and glittering particles darting rapidly throughout. With a magnifying glass, many of these will be seen to be copepods. Indeed, it would be difficult to find such a sample without copepods from any lake or sea.

Copepods have not propelled themselves to man's attention as have some insects, scorpions, centipedes, or spiders. However, some tropical freshwater copepods are intermediate hosts of tapeworms and the guinea-worm, a nematode parasitic on man. This worm can cause dangerous abscesses under the skin on the legs and arms. Humans acquire these parasites by eating infected fish (which have eaten the copepod carriers) or by drinking water with infected copepods. Likewise, it recently was shown that copepods can be a significant carrier of a long-known scourge, cholera.

Free-Living Copepods

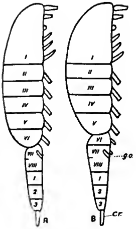
Copepods arrange themselves fairly well into free-living and parasitic forms. It will be seen that some of the latter required a long time to be recognized as animals, much less as copepods. Of the free-living species, some are of the open water and are termed "pelagic"; these may be passive or they may hop and skip around in the water, at times even giving the appearance of rain at the surface. Other free-living copepods are bottom-living and are termed "benthic"; these crawl on or burrow into the substrate.



This vignette represents a cutter and steamer, the former probably with some naturalist on a dredging expedition.

Different species of copepods are found at all depths in the oceans, and in all persistent bodies of fresh and brackish water. They have even been found in micropools formed in certain tropical plants high off the forest floor. A few copepods are luminescent; others have magnificent colors and stunning beauty.

If one takes as a simple example a free-living (that is, not parasitic) copepod, like the common freshwater *Cyclops*, it is seen (with the aid of a low-powered microscope) that the few-millimeter-long body is divided into segments of varying size and that there is no overlapping carapace, although the head segments and the first thoracic segment are always combined (a fusion of several ancestral segments). This complex, called the "cephalothorax," includes the head (with five pairs of appendages) as well as the first thoracic (maxilliped) segment and often the second thoracic segment. The cephalothorax is then followed by five (or four) thoracic segments; in some copepods, the last two thoracic segments can be fused. Each thoracic segment from the second to the sixth, fused or not, potentially bears a pair of swimming legs.



Copepod body types for calanoid (A) and cyclopoid (B). Prosome is segments I through VI; urosome is genital complex—segments VII (with genital opening, g.o.) and VIII—through caudal rami, c.r. Modified from Gurney (1931).

The head and thoracic segments together are sometimes referred to as the "prosome." The prosome, therefore, may have six, five, or four more-or-less distinct sections depending on which ancestral segments have fused.

The next distinct section usually comprises two segments (except in Platycopioida, fused in females); this is the genital complex, in part, at least, of thoracic origin. A pair of appendages (the "sixth legs"), if present, are mere buds, sometimes with setae.

The cylindrical segments posterior to the genital complex belong to the abdomen and do not bear appendages. There are usually three such segments in males. There can be three, two, or one corresponding distinct sections in females. The last abdominal segment ends in two caudal rami, not considered "segments." The last abdominal segment also has the anal opening. The genital complex, abdominal segments, and caudal rami together are sometimes referred to as the "urosome," the posterior counterpart of the prosome. The male urosome, therefore, usually has five distinct segments plus the caudal rami. In the female urosome, however, depending on which ancestral abdominal segments have fused, there are five, four, three, or two distinct sections, plus the caudal rami.

All copepods have an obvious pair of "feelers" or antennae at the anterior end, followed by a series of so-called "mouthparts," also paired, that will be described shortly. The last of the mouthparts are the paired maxillipeds, actually (from embryological considerations) the first of the thoracic appendages. Following this are four pairs of swimming legs, and, in our example *Cyclops*, a fifth pair obvious in some other copepods is represented only by minute structures on the first segment of the narrower posterior part of the body. All of these features are of the prosome.

It is the coalescence of the segments and the modifications of the appendages that, among other characters, indicate relationships among the many species. The functions of the different appendages may be shifted or shared: feeling, tasting, feeding, striking, grasping, walking, digging, swimming, and mating. All appendages to some degree or another are "armed" with minute teeth, spines, spinules, setae, setules, and sensory organs (esthetes).

There is general agreement that the first (embryological) segment of the copepod head has no appendages. All Crustacea, however, have two pairs of antennae, one pair on each of the next two following segments. In copepods, the first pair (also called antennules) is generally larger than the second, and always of a single branch (uniramous). The second antennae and all subsequent appendages are essentially biramous.

Continuing our review from front to back, the arrangement of the next few segments and their appendages has not been understood in the same way by all investigators. This is a morphologically complex region: segments have fused and their borders have disappeared, so that the attachments of appendages, as well as the structure of the developing or degenerating appendages themselves, are often hard to determine. The third appendage pair comprises the mandibles, showing great variety among the many types of copepods, with an edge for cutting, grinding, piercing, or sucking. For a long time, the presence of a mandible in a large copepod group was doubted by influential workers. However, it is now generally accepted that all copepods have mandibles, at least in juvenile stages (Bocquet and Stock 1963).

The thin and leaf-like first maxillae (maxilla, singular), the fourth appendage pair, are the least leg-like of any appendages. The second maxillae, the fifth pair, are generally several-segmented short, flattened appendages. The second maxillae may be arrayed with plumose setae where used as a food filter, or they may have stout spines when used for grasping.

The maxillipeds, the sixth appendage pair, often noticeably combine the function of mouthparts and leg, which is indicated by their name, translated from Latin as "jaw-feet." The maxillipeds are the most anterior of the thoracic appendages; that is, in spite of often being considered with the mouthparts, they are not head appendages. This confusion arises because the maxilliped segment is usually fused to the head segments (cephalon), and the function of the maxillipeds is to aid the mouthparts, rather than the following "swimming legs."

The evolutionary and embryological origin and nature of these last three appendage-pairs, and particularly the last two, have been controversial since the earliest morphological studies. One investigator or another has argued for two pairs of maxillae or two pairs of maxillipeds, conjecturing which part is outer and which part inner of the presumed two-branched primitive appendage, and which appendages properly belong to the posterior portions of the body. Some, as will be seen, even argued that the three pairs are but two, the last two being simply the inner and outer branches of a single appendage-pair.

The locomotory appendages ("swimming legs") are posterior to the pair of maxillipeds; basically there is one pair of legs for each of the next six segments, although in reality this pattern is usually modified. Most of the free-living copepods have only five pairs of legs. The fifth pair is usually lost or transformed, in connection with reproductive activities; this latter results in marked sexual differences. The variations in structure of these appendages in parasitic species are legion (Kabata 1979).

Most copepods leave the egg as a simple larval stage termed the "nauplius." The name *Nauplius,* from one of the legendary Argonauts, was given by the eighteenth-century Danish naturalist O. F. Müller to the immature *Cyclops* with the assumption that it was the adult of a distinct species.

Parasitic Copepods

In addition to having many free-living species, copepods show more abundant and diverse types of parasitism than any other crustaceans (Calman 1911). Nearly all other kinds of aquatic animals, even other crustaceans, have copepod parasites. Virtually every fish is a host to one or more species of parasitic copepod. Different species invade different parts of the fish anatomy: eyes, fins, gills, body surface, heart, liver, or nostrils. Some of these parasites are several inches long, and the largest (*Pennella,* up to one foot, not including the egg strings that could double this length) might be found on many kinds of fish, as well as some whales. The effects of these parasites on the economics of fisheries, both freshwater and saltwater, are often severe (Calman 1911, Kabata 1979).

In spite of the superficial resemblance and similar fish hosts of many species of large parasitic copepods, some of these species are now seen to be not closely related. This is an expression of convergent evolution, and it led to understandable confusion in the earliest literature.

Parasitism likely arose independently from several different kinds of free-living copepod forms. This "polyphyletic" origin better explains the array of parasitic species that have been described. A contrasting viewpoint would be that parasitism arose from one ancestral species and then proliferated into the present assortment.

All degrees of parasitism are demonstrated within the copepods, and all grades in between, from free predatory habits to a complete dependency of an attached saclike adult parasite upon the host. And still there are variations on this theme of all possible combinations: some copepods are free-swimming both in the youngest and oldest stages, with the intermediate age being parasitic.

Very few parasitic copepods have intermediate hosts in their life cycle. The pennellids, mentioned above in connection with their large size, are again unconventional. As in other copepods, the pennellids hatch as nauplii and soon for a short time are free-swimming copepodids that must find an intermediate host. The intermediate hosts are usually marine fish, rarely an invertebrate.

Mating takes place on the intermediate host, after which the males die. The females swim freely again in search of the final host. Again this is usually a fish, but it is sometimes a whale or other marine mammal. The final, bizarre appearance of the parasite depends in part on the host species, the location of the parasite on the host, and the age of the parasite. This plasticity confused most early investigators, and "species" descriptions far exceeded the number of real species examined. These mistaken species became as strongly embedded in the copepod literature as the parasite is on the host. To add to the complexity, and the source of early confusion, the intermediate hosts are usually not the same as the final hosts; also, both kinds of hosts can differ in a single parasite species from different regions:

> Although the presence of more than 700 [pennellid] juveniles on the intermediate host appears to produce no ill-effects, more than one adult female (largest number recorded was 11 on a single host) can have devastating, if not directly lethal, effects on the definitive host. (Kabata 1979)

Oddly enough, the transformation, in pennellids, to a plumelike external parasite is not regressive or degenerative, since most appendages are retained. The appendages are relatively small and fragile, and often missed or damaged. The body is considerably elongated and distorted, and segments have coalesced. The bulk of the final form is a greatly enlarged genital complex.

The tenacious and entrenched attachment of the parasites to the host also gives extra challenges to those who would examine them:

> It is unfortunate that *Haemobaphes* (a pennellid) is very difficult to dissect out without damage. Most collections of its species examined by the author consisted of beheaded specimens, a fact rather hampering taxonomic studies. (Kabata 1979)

There are also many copepod species that are neither free-living adults nor true parasites; these are the so-called commensal (or "associated") species that live in close and well-defined combinations with other organisms. The copepodologists of the future will have a nearly infinite variety of forms to investigate (Humes 1994).

By the late 1700s, free-living copepods were placed in the order Entomostraca, meaning "shelled insects," from the time when all free-living crustaceans except barnacles[1] were placed among the Insecta Aptera, or "insects without wings." In the mid-1800s, copepods comprised one subgroup within Entomostraca (raised to a subclass of the Class Crustacea), the order Copepoda. This was further divided into three suborders: (1) Gnathostoma, mouth with jaws; (2) Poecilostoma, mouth varies; and (3) Siphonostoma, mouth is a tube.

This vignette represents some fishermen drawing in a seine full of fish, on most of which these Crustacea attach themselves.

The working classification used in this treatise is that of Bowman and Abele (1982), wherein eight orders encompassed nearly all known copepods. In the decade following Bowman and Abele's publication, two more orders were added and other changes were made in the relative positions of some families. These changes are reflected in Table 1 (after Damkaer 1996). It is worth noting that each order is anchored on one genus, and that those ten genera taken collectively represent the distinct types of all copepods (now a subclass of its own). As a preview of where we will be headed, this classification of 208 families is inserted early.

All classifications have their origins with Linnaeus in 1758; Bowman and Abele's classification was given its essential structure one hundred years ago. Sars (1901) recognized seven distinct copepod types that he called suborders; in this treatise, Sars's surviving suborders will be considered "orders" (Bowman and Abele 1982). Sars's suborders (and the genera that defined them) were Calanoida (*Calanus*), Harpacticoida (*Harpacticus*), Cyclopoida (*Cyclops*), Monstrilloida (*Monstrilla*), Notodelphyoida (*Notodelphys*), Caligoida (*Caligus*), and Lernaeoida (*Lernaeocera,* called by Sars *Lernaea*). The first four of the seven suborders remain in the modern classification as orders, although many families have been moved in and out since Sars's time, as the definitions were made more precise. The Notodelphyoida were reduced to a family (Notodelphyidae) within a broadened Cyclopoida. The Caligoida and the Lernaeoida were also amended to family-level (Caligidae and Lernaeoceridae), but they were placed in a large new order Siphonostomatoida (*Ascomyzon* Thorell, 1859), with forty-nine families. As we shall see, an order Siphonostomatoida had long before been proposed by Thorell (1859) as one of three "series" embracing all copepods, and for essentially the same reasons, so that the "newness" of this category is only in its resurrection and its limits. This was true also of Sars's Cyclopoida, which he had proposed as early as 1886.

Likewise, a second Thorell series was reestablished as the order Poecilostomatoida (*Corycaeus* Dana, 1845), now with fifty-four families.

Two other orders, Misophrioida (*Misophria* Boeck, 1865) and Mormonilloida (*Mormonilla* Giesbrecht, 1891) were raised to this status in 1927 and 1979, respectively, from families established in the late nineteenth century. The most recently added orders are Platycopioida (*Platycopia* Sars, 1911) and Gelyelloida (*Gelyella* Rouch & Lescher-Moutoue, 1977) from 1985 and 1988. The present number of orders in this system is therefore ten, although four families established between 1870 and 1991 have not yet been assigned to an order (see Table 1).

In the century since Sars introduced this classification, a large number of families have been described, adding substantially to the within- and between-order details.

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[1] Barnacles placed variously in zoophytes, worms, or mollusks.

Table 1.

Copepod classification to family, including type genera of families (after Damkaer 1996). The original date of a preoccupied and replaced genus name is indicated by PN.

SUBCLASS COPEPODA Milne Edwards, 1830

Order CALANOIDA Sars, 1901

- Acartiidae Sars, 1903
  - *Acartia* Dana, 1846
- Aetideidae Giesbrecht, 1892
  - *Aetideus* Brady, 1883
- Arietellidae Sars, 1902
  - *Arietellus* Giesbrecht, 1892
- Augaptilidae Sars, 1905
  - *Augaptilus* Giesbrecht, 1889
- Bathypontiidae Brodsky, 1950
  - *Bathypontia* Sars, 1905
- Boholiniidae Fosshagen & Iliffe, 1989
  - *Boholina* Fosshagen, 1989
- Calanidae Dana, 1849
  - *Calanus* Leach, 1816
- Calocalanidae Bernard, 1958
  - *Calocalanus* Giesbrecht, 1888
- Candaciidae Giesbrecht, 1892
  - *Candacia* Dana, 1846
- Centropagidae Giesbrecht, 1892
  - *Centropages* Krøyer, 1849
- Clausocalanidae Giesbrecht, 1892
  - *Clausocalanus* Giesbrecht, 1888
- Diaixidae Sars, 1902
  - *Diaixis* Sars, 1902
- Diaptomidae Baird, 1850
  - *Diaptomus* Westwood, 1836
- Discoidae Gordejeva, 1975
  - *Disco* Grice & Hulsemann, 1965
- Epacteriscidae Fosshagen, 1973
  - *Epacteriscus* Fosshagen, 1973
- Eucalanidae Giesbrecht, 1892
  - *Eucalanus* Dana, 1852
- Euchaetidae Giesbrecht, 1892
  - *Euchaeta* Philippi, 1843
- Heterorhabdidae Sars, 1902
  - *Heterorhabdus* Giesbrecht, 1898 (PN 1863)
- Lucicutiidae Sars, 1902
  - *Lucicutia* Giesbrecht, 1898 (PN 1863)
- Mecynoceridae Andronov, 1973
  - *Mecynocera* I. C. Thompson, 1888
- Megacalanidae Sewell, 1947
  - *Megacalanus* Wolfenden, 1904
- Mesaiokeratidae Matthews, 1961
  - *Mesaiokeras* Matthews, 1961
- Metridiidae Sars, 1902
  - *Metridia* Boeck, 1865
- Paracalanidae Giesbrecht, 1892
  - *Paracalanus* Boeck, 1865
- Parapontellidae Giesbrecht, 1892
  - *Parapontella* Brady, 1878
- Parkiidae Ferrari & Markhaseva, 1996
  - *Parkius* Ferrari & Markhaseva, 1996
- Phaennidae Sars, 1902
  - *Phaenna* Claus, 1863
- Phyllopodidae Brodsky, 1950
  - *Phyllopus* Brady, 1883
- Pontellidae Dana, 1853
  - *Pontella* Dana, 1846 (PN 1828)
- Pseudocyclopidae Giesbrecht, 1893
  - *Pseudocyclops* Brady, 1872
- Pseudocyclopiidae Sars, 1902
  - *Pseudocyclopia* T. Scott, 1892
- Pseudodiaptomidae Sars, 1902
  - *Pseudodiaptomus* Herrick, 1884
- Ridgewayiidae M. S. Wilson, 1958
  - *Ridgewayia* I. C. Thompson & A. Scott, 1903
- Ryocalanidae Andronov, 1974
  - *Ryocalanus* Tanaka, 1956
- Scolecithricidae Giesbrecht, 1892
  - *Scolecithrix* Brady, 1883
- Spinocalanidae Vervoort, 1951
  - *Spinocalanus* Giesbrecht, 1888
- Stephidae Sars, 1902
  - *Stephos* T. Scott, 1892
- Sulcanidae Nicholls, 1945
  - *Sulcanus* Nicholls, 1945
- Temoridae Giesbrecht, 1892
  - *Temora* Baird, 1850
- Tharybidae Sars, 1902
  - *Tharybis* Sars, 1902
- Tortanidae Sars, 1902
  - *Tortanus* Giesbrecht, 1898 (PN 1883)

Order HARPACTICOIDA Sars, 1901

- Adenopleurellidae Huys, 1990
  - *Adenopleurella* Huys, 1990

- Aegisthidae Giesbrecht, 1892
  - *Aegisthus* Giesbrecht, 1891
- Ambunguipedidae Huys, 1990
  - *Ambunguipes* Huys, 1990
- Ameiridae Monard, 1927
  - *Ameira* Boeck, 1865
- Ancorabolidae Sars, 1909
  - *Ancorabolus* Norman, 1903
- Balaenophilidae Sars, 1910
  - *Balaenophilus* P. O. Aurivillius, 1879
- Cancrincolidae Fiers, 1990
  - *Cancrincola* C. B. Wilson, 1913
- Canthocamptidae Sars, 1906
  - *Canthocamptus* Westwood, 1836
- Canuellidae Lang, 1948
  - *Canuella* T. & A. Scott, 1893
- Cerviniidae Sars, 1903
  - *Cervinia* Brady, 1878
- Chappuisiidae Chappuis, 1940
  - *Chappuisius* Kiefer, 1938
- Cletodidae T. Scott, 1904
  - *Cletodes* Brady, 1872
- Cristacoxidae Huys, 1990
  - *Cristacoxa* Huys, 1990
- Cylindropsyllidae Sars, 1909
  - *Cylindropsyllus* Brady, 1880
- Darcythompsoniidae Lang, 1936
  - *Darcythompsonia* T. Scott, 1906
- Diosaccidae Sars, 1906
  - *Diosaccus* Boeck, 1872
- Ectinosomatidae Sars, 1903
  - *Ectinosoma* Boeck, 1865
- Hamondiidae Huys, 1990
  - *Hamondia* Huys, 1990
- Harpacticidae Dana, 1846
  - *Harpacticus* Milne Edwards, 1840
- Laophontidae T. Scott, 1904
  - *Laophonte* Philippi, 1840
- Latremidae Bozic, 1969
  - *Latremus* Bozic, 1969
- Longipediidae Sars, 1903
  - *Longipedia* Claus, 1863
- Louriniidae Monard, 1927
  - *Lourinia* C. B. Wilson, 1924 (PN 1866)
- Metidae Sars, 1910
  - *Metis* Philippi, 1843
- Miraciidae Dana, 1846
  - *Miracia* Dana, 1846
- Neobradyidae Olofsson, 1917
  - *Neobradya* T. Scott, 1892
- Paramesochridae Lang, 1948
  - *Paramesochra* T. Scott, 1892
- Parastenheliidae Lang, 1936
  - *Parastenhelia* I. C. Thompson & A. Scott, 1903
- Parastenocaridae Chappuis, 1933
  - *Parastenocaris* Kessler, 1913
- Peltidiidae Sars, 1904
  - *Peltidium* Philippi, 1839
- Phyllognathopodidae Gurney, 1932
  - *Phyllognathopus* Mrazek, 1893
- Porcellidiidae Sars, 1904
  - *Porcellidium* Claus, 1860 (PN 1840)
- Pseudopeltidiidae Poppe, 1891
  - *Clytemnestra* Dana, 1848
- Tachidiidae Sars, 1909
  - *Tachidius* Lilljeborg, 1853
- Tegastidae Sars, 1904
  - *Tegastes* Norman, 1903
- Tetragonicepsidae Lang, 1944
  - *Tetragoniceps* Brady, 1880
- Thalestridae Sars, 1905
  - *Thalestris* Claus, 1863
- Tisbidae Stebbing, 1910
  - *Tisbe* Lilljeborg, 1853

Order CYCLOPOIDA Sars, 1886

- Archinotodelphyidae Lang, 1949
  - *Archinotodelphys* Lang, 1949
- Ascidicolidae Thorell, 1859
  - *Ascidicola* Thorell, 1859
- Botryllophillidae Sars, 1921
  - *Botryllophilus* Hesse, 1864
- Buproridae Thorell, 1859
  - *Buprorus* Thorell, 1859
- Cyclopidae Burmeister, 1834
  - *Cyclops* Müller, 1776
- Cyclopinidae Sars, 1913
  - *Cyclopina* Claus, 1863
- Doropygidae Brady, 1878
  - *Doropygus* Thorell, 1859
- Enterocolidae Sars, 1921
  - *Enterocola* van Beneden, 1860
- Enteropsidae C. W. S. Aurivillius, 1885
  - *Enteropsis* C. W. S. Aurivillius, 1885
- Lernaeidae C. B. Wilson, 1917
  - *Lernaea* Linnaeus, 1758
- Mantridae Leigh-Sharpe, 1934
  - *Mantra* Leigh-Sharpe, 1934
- Mesoglicolidae de Zulueta, 1911
  - *Mesoglicola* Quidor, 1906

Notodelphyidae Dana, 1853
  Notodelphys Allman, 1847
Oithonidae Dana, 1853
  Oithona Baird, 1843
Ozmanidae Ho & Thatcher, 1989
  Ozmana Ho & Thatcher, 1989
Schizoproctidae C. W. S. Aurivillius, 1885
  Schizoproctus C. W. S. Aurivillius, 1885
Speleoithonidae da Rocha & Iliffe, 1991
  Speleoithona da Rocha & Iliffe, 1991

Order POECILOSTOMATOIDA Thorell, 1859
Amazonicopeidae Thatcher, 1986
  Amazonicopeus Thatcher, 1986
Anchimolgidae Humes & Boxshall, 1996
  Anchimolgus Humes & Stock, 1972
Anomoclausiidae Gotto, 1964
  Anomoclausia Gotto, 1964
Anomopsyllidae Sars, 1921
  Anomopsyllus Sars, 1921
Anthessiidae Humes, 1986
  Anthessius Della Valle, 1880
Bomolochidae Claus, 1875
  Bomolochus von Nordmann, 1832
Catiniidae Bocquet & Stock, 1957
  Catinia Bocquet & Stock, 1957
Chondracanthidae Milne Edwards, 1840
  Chondracanthus Delaroche, 1811
Clausidiidae Embleton, 1901
  Clausidium Kossmann, 1874
Clausiidae Giesbrecht, 1895
  Clausia Claparede, 1863
Corallovexiidae Stock, 1975
  Corallovexia Stock, 1975
Corycaeidae Dana, 1852
  Corycaeus Dana, 1845
Cucumaricolidae Bouligand & Delamare-Deboutteville, 1959
  Cucumaricola Peterson, 1958
Echiurophilidae Delamare-Deboutteville & Nunes-Ruivo, 1955
  Echiurophilus Delamare-Deboutteville & Nunes-Ruivo, 1955
Entobiidae Ho, 1984
  Entobius Dogiel, 1908
Erebonasteridae Humes, 1987
  Erebonaster Humes, 1987
Ergasilidae Burmeister, 1834
  Ergasilus von Nordmann, 1832
Eunicicolidae Sars, 1918
  Eunicicola Kurz, 1877
Gastrodelphyidae List, 1889
  Gastrodelphys Graeffe, 1883
Intramolgidae Marchenkov & Boxshall, 1995
  Intramolgus Marchenkov & Boxshall, 1995
Kelleriidae Humes & Boxshall, 1996
  Kelleria Gurney, 1927
Lamippidae Joliet, 1882
  Lamippe Bruzelius, 1858
Lernaeosoleidae Hogans & Benz, 1990
  Lernaeosolea C. B. Wilson, 1944
Lichomolgidae Kossmann, 1877
  Lichomolgus Thorell, 1859
Macrochirontidae Humes & Boxshall, 1996
  Macrochiron Brady, 1872
Myicolidae Yamaguti, 1936
  Myicola Wright, 1885
Mytilicolidae Bocquet & Stock, 1957
  Mytilicola Steuer, 1902
Nereicolidae Claus, 1875
  Nereicola Keferstein, 1863
Nucellicolidae Lamb, Boxshall, Mill, & Grahame, 1996
  Nucellicola Lamb, Boxshall, Mill, & Grahame, 1996
Octopicolidae Humes & Boxshall, 1996
  Octopicola Humes, 1957
Oncaeidae Giesbrecht, 1892
  Oncaea Philippi, 1843
Paralubbockiidae Boxshall & Huys, 1990
  Paralubbockia Boxshall, 1977
Pharodidae Illg, 1948
  Pharodes C. B. Wilson, 1935
Philichthyidae Vogt, 1877
  Philichthys Steenstrup, 1862
Philoblennidae Izawa, 1976
  Philoblenna Izawa, 1976
Pseudanthessiidae Humes & Stock, 1972
  Pseudanthessius Claus, 1889
Rhynchomolgidae Humes & Stock, 1972
  Rhynchomolgus Humes & Ho, 1967
Sabelliphilidae Gurney, 1927
  Sabelliphilus M. Sars, 1862
Sapphirinidae Thorell, 1859
  Sapphirina J. V. Thompson, 1829
Serpulidicolidae Stock, 1979
  Serpulidicola Southward, 1964
Shiinoidae Cressey, 1975
  Shiinoa Kabata, 1968

Spiophanicolidae Ho, 1984
Spiophanicola Ho, 1984
Splanchnotrophidae Norman & T. Scott, 1906
Splanchnotrophus Hancock & Norman, 1863
Synapticolidae Humes & Boxshall, 1996
Synapticola Voigt, 1892
Synaptiphilidae Bocquet & Stock, 1957
Synaptiphilus Canu & Cuenot, 1892
Taeniacanthidae C. B. Wilson, 1911
Taeniacanthus Sumpf, 1871
Tegobomolochidae Avdeev, 1978
Tegobomolochus Izawa, 1976
Telsidae Ho, 1967
Telson Pearse, 1952
Thamnomolgidae Humes & Boxshall, 1996
Thamnomolgus Humes, 1969
Tuccidae Vervoort, 1962
Tucca Krøyer, 1837
Urocopiidae Humes & Stock, 1972
Urocopia Sars, 1917
Vahiniidae Humes, 1967
Vahinius Humes, 1967
Vaigamidae Thatcher & Robertson, 1984
Vaigamus Thatcher & Robertson, 1984
Xarifiidae Humes, 1960
Xarifia Humes, 1960

Order SIPHONOSTOMATOIDA Thorell, 1859
Archidactylinidae Izawa, 1996
Archidactylina Izawa, 1996
Artotrogidae Brady, 1880
Artotrogus Boeck, 1859
Ascomyzontidae Thorell, 1859
Ascomyzon Thorell, 1859
Asterocheridae Giesbrecht, 1899
Asterocheres Boeck, 1859
Brychiopontiidae Humes, 1974
Brychiopontius Humes, 1974
Caligidae Burmeister, 1834
Caligus Müller, 1785
Calverocheridae Stock, 1968
Calverocheres C. B. Wilson, 1932 (PN 1902)
Cancerillidae Giesbrecht, 1897
Cancerilla Dalyell, 1851
Catlaphilidae Tripathi, 1960
Catlaphila Tripathi, 1960
Cecropidae Dana, 1852
Cecrops Leach, 1816
Choniostomatidae Hansen, 1887
Choniostoma Hansen, 1887
Chordeumiidae Boxshall, 1988
Chordeumium Stephensen, 1918
Coralliomyzontidae Humes & Stock, 1991
Coralliomyzon Humes & Stock, 1991
Dichelesthiidae Milne Edwards, 1840
Dichelesthium Hermann, 1804
Dinopontiidae Murnane, 1967
Dinopontius Stock, 1960
Dirivultidae Humes & Dojiri, 1980
Dirivultus Humes & Dojiri, 1980
Dissonidae Yamaguti, 1963
Dissonus C. B. Wilson, 1906
Dyspontiidae Giesbrecht, 1895
Dyspontius Thorell, 1859
Ecbathyriontidae Humes, 1987
Ecbathyrion Humes, 1987
Entomolepididae Brady, 1899
Entomolepis Brady, 1899
Eudactylinidae C. B. Wilson, 1932
Eudactylina van Beneden, 1853
Euryphoridae C. B. Wilson, 1905
Euryphorus Milne Edwards, 1840
Hatschekiidae Kabata, 1979
Hatschekia Poche, 1902
Herpyllobiidae Hansen, 1892
Herpyllobius Steenstrup & Lutken, 1861
Hyponeoidae Heegaard, 1962
Hyponeo Heegaard, 1962
Kroyeriidae Kabata, 1979
Kroyeria van Beneden, 1853
Lernaeoceridae Gurney, 1933
Lernaeocera de Blainville, 1822
Lernaeopodidae Milne Edwards, 1840
Lernaeopoda de Blainville, 1822
Lernanthropidae Kabata, 1979
Lernanthropus de Blainville, 1822
Megapontiidae Heptner, 1968
Megapontius Hulsemann, 1965
Melinnacheridae Bresciani & Lützen, 1975
Melinnacheres M. Sars, 1870
Micropontiidae Gooding, 1957
Micropontius Gooding, 1957
Myzopontiidae Sars, 1915
Myzopontius Giesbrecht, 1895
Nanaspididae Humes & Cressey, 1959
Nanaspis Humes & Cressey, 1959
Naobranchiidae Yamaguti, 1939
Naobranchia Hesse, 1863
Nicothoidae Dana, 1852
Nicothoe Audouin & Milne Edwards, 1826

Pandaridae Milne Edwards, 1840
    Pandarus Leach, 1816
Pennellidae Burmeister, 1834
    Pennella Oken, 1816
Phyllodicolidae Delamare-Deboutteville & Laubier, 1960
    Phyllodicola Delamare-Deboutteville & Laubier, 1960
Pontoeciellidae Giesbrecht, 1895
    Pontoeciella Giesbrecht, 1895
Pseudocycnidae C. B. Wilson, 1922
    Pseudocycnus Heller, 1865
Rataniidae Giesbrecht, 1897
    Ratania Giesbrecht, 1892
Sphyriidae C. B. Wilson, 1919
    Sphyrion Cuvier, 1830
Spongiocnizontidae Stock & Kleeton, 1964
    Spongiocnizon Stock & Kleeton, 1964
Stellicomitidae Humes & Cressey, 1958
    Stellicomes Humes & Cressey, 1958
Tanypleuridae Kabata, 1969
    Tanypleurus Steenstrup & Lutken, 1861
Trebiidae C. B. Wilson, 1905
    Trebius Krøyer, 1838
Ventriculinidae Leigh-Sharpe, 1934
    Ventriculina Bassett-Smith, 1903
Xenocoelomatidae Bresciani & Lützen, 1966
    Xenocoeloma Caullery & Mesnil, 1915

Order MONSTRILLOIDA Sars, 1901
Monstrillidae Dana, 1849
    Monstrilla Dana, 1849

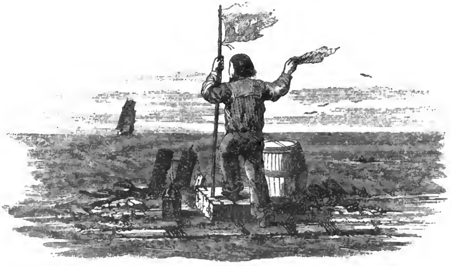
Order MISOPHRIOIDA Gurney, 1927
Misophriidae Brady, 1878
    Misophria Boeck, 1865

Order MORMONILLOIDA Boxshall, 1979
Mormonillidae Giesbrecht, 1892
    Mormonilla Giesbrecht, 1891

Order PLATYCOPIOIDA Fosshagen, 1985
Platycopiidae Sars, 1911
    Platycopia Sars, 1911

Order GELYELLOIDA Huys, 1988
Gelyellidae Rouch & Lescher-Moutoue, 1977
    Gelyella Rouch & Lescher-Moutoue, 1977

Order uncertain
Antheacheridae M. Sars, 1870
    Antheacheres M. Sars, 1857
Chitonophilidae Avdeev & Sirenko, 1991
    Chitonophilus Avdeev & Sirenko, 1991
Sponginticolidae Topsent, 1928
    Sponginticola Topsent, 1928
Staurosomatidae de Zulueta, 1911
    Staurosoma Will, 1844



1

CLASSICAL COPEPODS

Blessed is he who contemplates the ageless order of
immortal nature, how it is constituted and when and why.
—EURIPIDES, CA. 410 B.C.

THE SEAS were honored and respected in the ancient world. They were a source of food, a passageway and a barrier, the mainspring of storms, and the home of gods. Such an obvious part of nature had to be accommodated in any cosmic plan.

Aristotle

384–322 B.C.

The Greek philosopher Aristotle had pondered a variety of beliefs bearing on the known universe; in his judgment, these were mostly myths. One theory Aristotle attributed to others, but which he favored, was that the seas were warmed and evaporated by the sun. The water vapor then cooled and fell as rain, which was the origin of springs and rivers; the whole cycle repeated again and again.

Aristotle was born in Macedonia within the social circle of the king. Aristotle is renowned for many activities, not least of which was tutor to the young Alexander, soon to be conqueror of the world. In 334 B.C., Aristotle founded a school (the Lyceum) that emphasized natural science, instead of mathematics, metaphysics, politics, and rhetoric stressed in rival schools. Aristotle's outstanding innovation was that he accepted only observations as the source of knowledge; in so doing, he could be called the Father of the Scientific Method. Another innovation was the use of his students to gather information in many fields, especially on the structure and habits of animals. Alexander also committed his weighty resources to this effort, making it the first recognized cooperative scientific research. Aristotle thereby procured the first scientific collection of plants and animals, mostly from the Aegean countries. One of Aristotle's many surviving messages was that "In all natural objects there lies some marvel, and if any one despises the contemplation of the lower animals, he must despise himself" (Durant 1939).

Aristotle contemplated a number of ways to classify animals, but the most persistent was the grouping into "blooded" and "bloodless." This latter group corresponds approximately to the invertebrates and was further subdivided into testaceans (shelled mollusks), mollusks (i.e., soft mollusks and worms), insects, and crustaceans (i.e., those with a heavy, crusty shell). If anyone in antiquity had taken the measure of the free-living copepods, they would have found as ready a place in Aristotle's Insecta as they did in Linnaeus's, two thousand years later. Parasitic copepods, however, were placed in very different company.

In Aristotle's school, considerable effort went toward the study of feeding and reproduction in animals. Aristotle anticipated some notions of nineteenth-century biology, such as an embryo's characters belonging to the level of genus appear first, then those belonging to the species, and finally those of the individual. He also came very close to evolutionary principles when he recorded that "Nature proceeds little by little from things lifeless to animal life in such a way that it is impossible to determine the exact line of demarcation. . . . There are certain objects in the sea concerning which one would be at a loss to determine whether they be animal or vegetable" (Durant 1939).

Aristotle's description of 180 different Aegean Sea animals is the precursor of all subsequent publications in marine biology. Aristotle knew coelenterates could sting, and he called them Acalephae after the Greek name for nettles; among the Acalephae known to Aristotle were the sea pens, now called Pennatulacea. Aristotle placed them intermediate between plants and animals, under the category "Zoophyta." But many indeterminate soft-bodied animals such as sponges, ascidians, bryozoa, and parasitic copepods were eventually also included in the catchall Zoophyta, where they remained for centuries (Hyman 1940). The superficial resemblance of some parasitic copepods (namely *Pennella*) to the sea pens ensured their merging in the zoophyte classification, even though they are at utterly different branches of the animal kingdom.

Notwithstanding many sparks of insight and solid work for which Aristotle will be forever remembered, there are many and grievous errors. Still, even with our overview of twenty-three centuries, Aristotle's *Historia Animalium* is a commanding work and the greatest scientific harvest of ancient Greece. In biology, there was nothing comparable for two thousand years. This science had no definite beginning, else Aristotle might be termed the Father of Biology. However, he accomplished more in this area than any other ancient of whom we have a record (Durant 1939). Later years gave exceptional weight to Aristotle's commentaries, especially if there were no contradicting observations.

The first knowledge of parasitic copepods must be looked for in those early times. Aristotle's vast and important studies were the most diligent and deep observations of all antiquity. He was apparently the first to record the existence of these copepods, easily seen when fish are handled; no doubt fishermen brought them to his attention. Aristotle remarked in his "History of Animals" that "tuna and swordfish are tormented as a dog by a gadfly, by a worm under the fins, which looks like a scorpion, has the size of a spider, and causes such anguish that not infrequently the swordfish jump out of the water like dolphins, even falling into the boat" (Brian 1906).

It is a fact that this parasitic copepod is found with a certain frequency on tuna and always near the fins, thus it would seem strange and could easily have excited the imagination of the first observers. It was only natural that Aristotle credited this animal with the form of a scorpion, maintaining the notion of discomfort to the host. Because of the parasite's varied extremities, caudal appendages, and egg sacs resembling feet, these could be thought of as sucking organs. It is admirable that Aristotle compared its size to that of a spider, and did not compare it to "insects" other than scorpions based on its external aspect. On the other hand, it had some characteristics of a worm, since Aristotle used the term "verminculum." There were arguments much later that perhaps this parasite was an isopod, rather than a copepod, but the notation "worm," together with the other descriptive points, places it with the copepods. This uncertainty by Aristotle is hardly surprising, considering that even into the 1800s, zoologists were undecided about placing these organisms with insects, crustaceans, worms, or mollusks, or even into a separate group.

"Aristotle contemplating Nature," as conceived by Valmont de Bomare in 1791. Courtesy of the National Library of Medicine.

Pliny the Elder

A.D. 23–79

The ancient Greeks passed on to their cultural successors what they knew about animal life, and except for a new observation here and there, this did not change appreciably for a vastly long time. The Roman scholar Pliny the Elder organized all knowledge of natural science in his encyclopedic thirty-seven-book *Historia Naturalis.* Pliny, a cultured man of letters and science, gave a good repetition of Aristotle's observations, almost word for word. Of the parasitic copepod, Pliny said that "the animal is small, looks like a scorpion, has the size of a spider.

When the tuna and the swordfish are crowded together even more than dolphins, this is fastened at a point under the fins and inflicts so much discomfort, that they often jump into the boats. They run as one fearing the whip, so fast that they jump shaking across the boat" (Brian 1906).

Of the many publications about Pliny and his natural history, I cite one old (Urlichs 1857)—with an exquisite bookplate of Charles Atwood Kofoid (1865–1947), who mixes briefly with copepods at the end of the nineteenth century—and one new (Dennis 1995). Pliny's death as a martyr to science has often been mentioned. Rather than flee an eruption of Mt. Vesuvius, Pliny the "Ever Curious" went toward the hazard, and perished. Pliny the Younger described in a long passage how the pumice stones, flame, and sulfurous fumes overcame his famous uncle (Urlichs 1857).

The process of restating older work began a downward trend; firsthand obsetvations were neglected, if not avoided, and medieval authors did not often go back even to the classical authors. A common medieval phrase, reworded in our own time, marked the indifference those scholars showed for the earliest authors: "Graecum est, non potest legi" [It is Greek; it cannot be read]. Sometimes they did not even start with the old Pliny, which was still the foremost scientific work of medieval Europe. They were careless and committed to telling wonder tales (Muntz 1995). In the Byzantine Empire and eastern Mediterranean societies, there was more availability of and reliance on the earlier Greek texts, but in the main there was an unenlightened atmosphere (Durant 1939).

The Middle Ages have been called a period of silence. Up to the twelfth century this covered all science and especially carcinology. The Middle Ages do not have a definite closing date, but much of the silence surrounding science persisted during the thirteenth, fourteenth, and fifteenth centuries. Zoology began to unfold during this period, but chiefly in regard to vertebrates; there was little enough of that, and nothing for crustaceans. Even into the sixteenth and seventeenth centuries there was not much new in zoology, with frequent references to the ancient writings of Aristotle and Pliny.

From Pliny's time into the Middle Ages, zoology was scarcely viable. But during the Renaissance, philosophers and scholars started to look more seriously at the classical texts and the origins of various notions. A prime example was Copernicus's new model in 1512 of the earth revolving about the sun.

GVLIEL. RONDELETIVS.

Guillaume Rondelet (1507–1566). From the portrait in his "Book of Marine Fishes" of 1554.

Increasing knowledge was aided most by discovery and exploration of new countries. The Crusades, the journeys of Marco Polo, the extended voyages of the Portuguese in the fifteenth century, and finally the discovery of the New World provided a mass of material to biology that could not be reconciled only through Aristotle. A burgeoning descriptive literature could now be widely distributed, thanks to the craft of book printing that began in the 1450s. Printing also incorporated woodcuts and copper engravings to add illustrations to texts. Biology began to distance itself from the classical authors and to base itself on experiences gained by direct observations. By classifying these observations, new kinds of zoologists sought the ultimate laws of nature. They ended the 1500s by undermining the foundations of the ancient concepts of life and its forms.

New thoughts were not without risks—not just risks that "exposed the author to the obloquy and censure which are the usual portions of an original observer" (Johnston 1847), but physical threats to every dear thing. That Servetus in 1553 and Bruno in 1600 were burned at the stake, and Galileo nearly so in 1615, could not be overlooked by their colleagues, themselves tempting the rack-masters.

Guillaume Rondelet

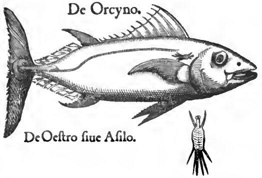
27 September 1507–30 July 1566

One of these emerging zoologists was Guillaume Rondelet, born in Montpellier in the south of France. His father was a druggist and supported his son's wishes to study medicine at the University of Montpellier. Rondelet received his M.D. in 1537. In 1545, he was named Royal Professor in the Faculty of Medicine.

It was not unusual at that time to be both physician and professor. Unusual, however, was that Rondelet traveled and studied, in his case, with a wealthy cardinal as patron. Rondelet was able to visit the ocean coast to further his interest in natural history. In 1549, he spent three months in Rome. In 1551, he and the cardinal went to Venice, stopping at the principal Italian universities (Fisquet 1863).

Rondelet was a bright light at the end of a long night for zoology. His main studies were on aquatic animals, and in this field he outdistanced his forerunners as well as his contemporaries. Rondelet's (1554) fame rests on *Libri de Piscibus Marinus* ["the book of marine fishes"], in which he described and illustrated the aquatic animals known to him. He considered as fishes not only fish but also whales, seals, crustaceans, mollusks, echinoderms, worms, and various other invertebrates. Rondelet corrected Aristotle on several points, but he was hampered by a cumbersome classification, with no clear idea of species. It is not surprising that he failed to relate vertebrates to invertebrates by dissection and comparative anatomy.

Rondelet's *Piscibus Marinus* restated Aristotle's and Pliny's reports on the parasite of tuna and swordfish. What was new, however, was Rondelet's proof of it by personal knowledge of the little animal relayed in a subtreatise under the title "De Insectis et Zoophyt." Rondelet offered two names, the marine "horsefly" (*Oestrus*) or the marine "gadfly" (*Asilus*), as well as an illustration of a tuna with the parasite attached near the pectoral fin. Its adherence, he wrote, is so tenacious that it does not even come off if one shakes the body of the host. It is generally accepted that this is *Brachiella thynni* Cuvier, 1830, a large and easily noticed species (Brian 1906, Kabata 1979). Rondelet's figure is the oldest known representation of a copepod. He also figured the copepod separately, although without added details.


De Orcyno.
De Oeſtro ſiue Aſilo.

The first published illustration of a copepod, in this case a parasite on the Mediterranean tuna. The copepod, called the "Oestro" or "Asilo," is seen above the fish's pectoral fin. The lower figure is an enlarged view of the copepod. From Rondelet (1554).

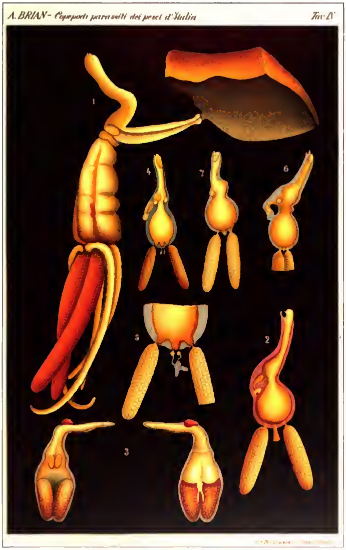
"Conrad Gessner, physician and philosopher. Born in Zurich 1516, died in the same place 13 December 1565. He wrote many books, great enough to delay death, That you would wish for your Medical Library." From Adler (1989).

Conrad Gessner

26 March 1516–13 December 1565

The zeal of the era is confirmed by the appearance of another zoological text on the heels of Rondelet's. Conrad Gessner, Professor of Natural History at Zurich, Switzerland, was the most important zoologist of the Renaissance. He had studied and worked with Rondelet in Montpellier (Mahly 1879). His major work was the *Historia Animalium*, a four-volume synthesis (thirty-five hundred pages) in Pliny's pattern and with Aristotle's classification. In fact, Cuvier had called Gessner "the German Pliny" because of his attainments in so many fields (Garrison 1914). The first three volumes covered quadrupeds, birds, and fishes; the fourth, published after Gessner's death from the Black Plague, dealt with reptiles and insects. Gessner's work was based on his broad firsthand experience and that of scientists with whom he corresponded, and so contained much more detail than any previous offerings (Wellisch 1975).

In a section titled "de Aquatilibus" (1558), published in the same year Queen Elizabeth I began her long reign, Gessner inserted a parallel discourse on Rondelet's parasitic copepod. Gessner described the structure and appearance of this celebrated copepod, saying that "because they are so small, few things about this parasite have been noted, except that at the time of the rising dog-star [summer] they appear not upon several kinds of fish but only on the tunas, swordfish, and occasionally on the dolphin [fish?], and then not even on every individual." He added a figure of it in place on the tuna, just like Rondelet's earlier figure. He observed that "this animal adheres very strongly so that it cannot be removed except by pulling it off. It sucks the blood of the fish, like a leech. At the end of this time if it gets too full it moves, and establishes itself on some fish (the tuna in particular), striking the weak and wretched during the height of summer. The fish become very miserably tormented with this plague, which strikes more easily into fish schools at this time than it would in winter." Gessner said that the specimen he himself had examined was white and was discovered adhering to a "Pagrum fish" (sea bream, *Pagrus pagrus*) (Brian 1906). If, as is likely, Gessner was looking at a *Brachiella* species, he was wrong about it changing hosts; the mature female is permanently attached.


A. BRIAN - Copepodi parassiti dei pesci d'Italia
Tav. IV
1
4
7
6
5
2
3

The parasitic copepod Brachiella thynni *(Fig. 1), the presumed "Oestro" of Aristotle, Rondelet, and Gessner. Related species are in the genera* Clavella *(Figs. 2, 4–7) and* Naobranchia *(Fig. 3). From Brian (1906).*

* * *

Up to this time, the objects of attention of the naturalists were probably species of the copepod genus *Brachiella* and similar forms, but their descriptions were so vague that some of them may have been looking at other crustaceans, like isopods, as well. It was not until the late 1600s that better drawings were produced, and more details supplied, to enable us to say with certainty that copepods were the objects in focus.

2

SOMETHING ABOUT MICROSCOPES

> Was ist das Schwerste von allem?
> Was dich das Leichteste dünkt:
> Mit den Augen zu sehn,
> was vor den Augen dir liegt!
> —Johann Wolfgang Goethe, *Sprüche in Prosa*

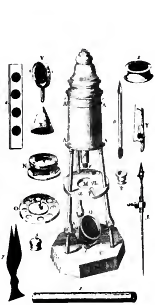
OF COURSE, Goethe meant that the most difficult thing of all is to see with a wholly rational and undistorted perspective that which is in front of you. However, it is equally true that if you cannot physically see the object of your attention, no amount of reasoning will make it distinct. Species discrimination in copepod studies, as well as other intelligence, was tied to the development of microscopes. Several of the earliest investigators of copepods mentioned their prized instruments. With others, the primary goal was the perfection and promotion of the microscope; copepods were viewed only incidentally.

The Compound Microscope

Single lenses to magnify already visible objects had been used since antiquity. The use of lenses in combination led to the invention (perhaps better described as a "discovery") of the telescope and the microscope, probably independently by several technicians, although Galileo (1564–1642) often is credited with the creation of both (1609–1612). The microscope as a device used to view objects too small to be seen by the unaided eye actually dates from the end of the sixteenth century. By 1624, opticians in Italy, England, and Holland were making practical instruments, with which the scientific community (particularly medicine and botany) made rapid and abundant advances.

The next important date in the progress of microscopes was 1665, when Robert Hooke, Secretary of the Royal Society of London, published *Micrographia,* the first comprehensive work on the instrument's theory, construction, and potential. For the next one hundred years, there was little change: the objective was a double (bi-) convex lens of short focal length attached to the bottom of a tube; a large simple magnifying lens, to enlarge the field of view, was fixed near the top of the tube; about one inch above the field lens, at the top of the tube, was the biconvex eye-lens (ocular), protected and shaded by a cup. These multilensed instruments were "compound" microscopes. One of Hooke's microscopes exists as a national treasure of the British Museum (Clay and Court 1975).

After Hooke's time, compound microscopes used a variety of lens combinations–with differing convex, concave, and plane surfaces–to improve the flatness of the field. Condensers were added to better control the light. Draw tubes with coarse and fine adjustments changed the distances between lenses, and therefore also the magnification, as well as the distance from lens to object, and therefore also the focus. Many of the earliest microscopes were truly works of art, with turned, knurled, and lacquered rare woods, and inlays of ivory and precious metals. The outward appearance of the basic instrument resembled Hooke's until the mid-1700s, although by then most were made of brass.



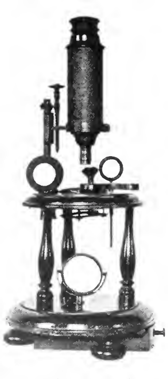
Culpeper and Scarlett's double reflecting microscope and accessories. From Baker (1754).

Baker (1754) extolled the virtues of Culpeper and

Scarlett's double reflecting microscope (Clay and Court 1975), and left a precise description of its use:

> The *Double Reflecting Microscope,* in use at present, (whose Picture with its Apparatus is seen Plate III.) is an Alteration and Improvement by Mr. Culpeper and Mr. Scarlett, of Mr. Marshal's *large Double Microscope;* than which it is less cumbersome, may be managed with much more Ease, and by means of a reflected Light, is capable of shewing Objects in a clearer and more pleasing Manner.
>
> The Body of this Microscope A A A A, being a large Tube, is supported by three Brass Pillars *b b b,* rising from a wooden Pedestal C; in which Pedestal is a Drawer D, to hold the Object-Glasses and other Parts of the Apparatus.
>
> A lesser Tube *e e,* slides into the greater, and sends from its Bottom another Tube much smaller than itself, *f,* with a male Screw *g,* at the End thereof, whereon to screw the Object-Glass or Magnifier.
>
> There are five of these Magnifiers, number'd 1. 2. 3. 4. 5. which Numbers are also marked on the inner Tube, to direct where-about to place it according to the Magnifier made use of: but if then it fits not the Eye exactly, slide the inner Tube gently higher or lower, turn the Screw of the Magnifier, gradually, till the Object appears distinct.—Take Notice, that the greatest Magnifiers have the smallest Apertures and the Lowest Numbers.
>
> L. is a circular Plate of Brass, fixt horizontally between the three Brass Pillars, and in the Center thereof a round Hole M. is adapted to receive a proper Contrivance N. for holding Ivory Sliders wherein Objects are placed: which Contrivance consists of a spiral Steel Wire confined between three Brass Circles, one whereof is moveable for the Admission of a Slider.
>
> O. is a round Brass Plate, with several Holes for placing Objects in, some of which are usually furnish'd with them at the Shops: but two Holes are commonly reserved for small concave Glasses, whereon to place a Drop of any Liquid, in order to view the Animalcules, &c. There is also a Piece of white Ivory, and a Piece of black Ebony, of the same Size and Shape as the Holes for Objects: the Ivory is to put opake Objects on that are black, and the Ebony is to receive such as are white; by which Contrariety of Colours they will be seen more clearly.—At the Bottom of this Object-Plate is a Button to slip into a Slit P. that fits it, on the circular Plate of Brass: and by turning it round on this Pin, all the Objects may be examin'd successively with very little Trouble.
>
> Q. is a concave Looking-glass, set in a Box of Brass, and turning in an Arch R. upon two small Screws *s s.* From the Bottom of the Arch comes a Pin, which being let down into a Hole *t.* in the Center of the Pedestal, enables the Looking-glass to turn vertically, or horizontally, and reflect the Light, either of a Candle, or the Sky, directly upwards on the Object to be viewed. . . .
>
> 4. is a flat Piece of Ivory called a Slider, with four round Holes through it, and Objects placed in them between *Muscovy* Talcs or Isinglass, kept in by Brass Wires.
>
> It is proper to have a Number of these Sliders filled with curious Objects, always ready, as well as some empty ones, for any new thing that offers. When made use of, thrust them between the Brass Rings of the Contrivance on purpose for them, N. which shoots into the round Hole M. in the Center of the Brass Plate L. This keeps them steady, and at the same time permits them to be moved to and fro for a thorough Examination.
>
> A little Ivory round Box 5. to hold pieces of Isinglass for the Sliders.
>
> 6. a small Hair Brush, to wipe any Dust off the Glass, or to apply a Drop of any Liquid.
>
> 7. a pair of Nippers, to take up any Object to be examined. (Baker 1754)

A major advance in practicality and proficiency was made by John Cuff, London, in 1744. Innovations in this instrument were influenced by Baker. Cuff's new design was an all-brass, compact compound microscope, with stage, adjustable mirror, condenser, and both coarse and fine focusing. It had a decidedly "modern" look (Clay and Court 1975). This was so successful that it immediately replaced the models of most other makers, who therefore had to copy it to compete. Some of these copies were referred to as "Cuff's" microscopes. Cuff-type microscopes were the best available until about 1850, although any of these in good condition would have pleased their owners and remained in good service long after this time. Cuff, like other makers, also sold simple microscopes, and references to "Cuff's microscopes" may have been to either type.



A compound microscope of the type used in the late eighteenth century. From Dahl (1941).

The Simple Microscope

By the 1660s, commercial microscopes with graduated sets of magnifying powers of single lenses were available. Because of their longer working distances (between object and lens) and relative ease of use, these early microscopes were much admired. The reality was that most early biological research with the "microscope," including the important discoveries of Leeuwenhoek and others, were based on the use of a "simple" microscope. There were many and ingenious variations of these, but the basic form was constant: a spherical or biconvex lens held by two flat metal plates each with a small hole drilled to hold the lens. A single instrument would often have a number of interchangeable lenses. The magnification usually ranged from 40x to 160x (Clay and Court 1975). The object was held by a threaded rod, which also allowed controlled movement across the lens opening. There was a short screw fastened to this rod and perpendicular to the metal plates; this allowed the object to be put in focus. A successful practitioner needed a good lens, but a more important requirement was an outstanding skill in dissecting and mounting the objects of interest.

"Simple" microscopes were used for scientific studies from 1590 to around 1850. It is likely that most work on copepods to that time was conducted with these single-lens magnifiers. By the early 1700s, some of the simple microscopes were mounted in screw-barrels with light-controlling diaphragms, giving improved convenience and performance. These were the first "pocket" microscopes. Cuff of London made a simple microscope that consisted of a set of interchangeable lenses and a mirror attached to a removable rod mounted on a base; the whole set disassembled and went into a compact case. Linnaeus had one like this (Ahlstrom 1949). Gunnerus (1770) referred to his Cuff's magnifying glass, probably also of the simple configuration.

An early entomologist, facing his laboratory's window, uses a hand-held microscope to examine an insect. The cases on the left held specimens of labeled insect orders. The right half of the opened cupboard is dedicated to "Insecta aquatica" and likely held a number of copepods. This wood engraving (from 1722) was by the son of the German naturalist Johann Leonard Frisch (1666–1743), who described an argulid in 1730 (Wilson 1902, Howard 1930). Courtesy of the National Library of Medicine.

A compound microscope of the type used in the mid-nineteenth century. From Gosse (1874).

Müller recorded some practical advice about microscopes (Anker 1950) and even left us with a drawing of one of his instruments (Müller 1788a,b).

* * *

Suppose (when thought is warm, and fancy flows,
What will not argument sometimes suppose?)
An isle possess'd by creatures of our kind,
Endued with reason, yet by nature blind.
Let Supposition lend her aid once more,
And land some grave optician on the shore:
He claps his lens, if haply they may see,
Close to the part where vision ought to be;
But finds that though his tubes assist the sight,
They cannot give it, or make darkness light.
He reads wise lectures, and describes aloud
A sense they know not to the wond'ring crowd;
He talks of light, and the prismatic hues,
As men of depth in erudition use;
But all he gains for his harangue is—Well!—
What monstrous lies some travellers will tell!

—William Cowper, *Charity*, 1782

3

CITY AND COUNTRY GENTLEMEN

> Investigation of the world of small organisms, of all the crawling, flying, swimming, and drifting creatures which, until the end of the eighteenth century, came under the general heading of "insects," has always been an activity for men and women of quiet, modest, and totally undramatic character.
>
> —Herbert Wendt, *Out of Noah's Ark*

> [In contradiction:]
> If you inquire what the people are like here, I must answer, "The same as everywhere!"
>
> —Johann Wolfgang Goethe, *Die Lieden des Jungen Werthers*

THE SEVENTEENTH CENTURY will be remembered as one of the golden ages, newfound intellectual liberty resounding with a fervor for the general increase in knowledge, particularly of the natural world. The new science of biology developed under the titans of the field, like Harvey, Descartes, Leibniz, Newton, Malpighi, Ray, and Leeuwenhoek. There was an invigoration of aquatic sciences in the broad sense, inspired by newly revealed natural wonders. The century saw an energizing of scientific societies, admitting that progress compelled combined efforts, and that isolated observations and sound reasoning were not enough. An author's affiliation with one or many "academies" was proudly listed on title pages, generally in preference to associations with universities. Yet, as before, progress was based ultimately on individuals, and remarkable contributions were followed by idle stages. The old Aristotelian ideal surfaced: only by looking at natural objects or events could true knowledge be acquired. For the scientists of the 1600s, this was a revolution. Man's attitude to nature, and especially to flora and fauna, both reflected and influenced the momentous changes taking place.

Thomas Moffett

? 1553–ca. 3 June 1604

The first naturalist to notice a copepod species that differed from Rondelet's *Asilus* was the fashionable English physician Thomas (Thommaso) Moffett (sometimes spelled Mouffet), who, in his *Insectorum sive minimorum Animalium Theatrum,* published posthumously in London in 1634 (Miall 1912, Beiet 1973, Dance 1978), included a crude figure of an animal that, if not a parasitic isopod, is probably a fish parasite of the copepod genus *Dichelesthium* (not described adequately until 1804 by J. F. Hetmann). Apparently Moffett did not indicate the host species; he was not the last who was guilty of this or, worse, of misidentifying the host (Brian 1906). Especially when descriptions are poor, numerous records from doubtful hosts remain in a literature limbo.

Moffett was born in London, the second son of a Scottish haberdasher. He became a Cambridge student at sixteen, graduated in 1572, and obtained an M.A. in 1576. Moffett then took up medical studies in Basel, Switzerland, under one of Rondelet's students. He published his medical thesis there in 1578 and traveled through Italy, Spain, and Germany before returning to England. Cambridge awarded him his

(left) ***Thomas Moffett (1553–1604). From Heltzel and Hudson (1940).***

(right) ***Paulo Boccone (1633–1704), from his 1697*** Museo di fisica e di esperienze variato . . . : ***"Master Paulus Boccone, now Sylvius, the tireless investigator of the natural kingdom at age 64." Courtesy of the National Library of Medicine.***

M.D. in 1582. In that year, Moffett was a participant in a state visit to Denmark, where he incidentally became acquainted with the astronomer Tycho Brahe (1546–1601). After the early period of study, Moffett began a long dedication to both his medical practice and natural history, but "he was emphatically not a great naturalist or a first-hand student" and the *Theatrum* was "a monument to the past rather than a searchlight into the future" (Raven 1947). In 1591, Moffett was in Normandy as physician to the troops under the Earl of Essex. In 1597, when he was physician to the Earl of Pembroke, Moffett became a member of Parliament. He published several books and papers, mainly on medical subjects. He also had numerous contacts with Sir Francis Drake (Heltzel and Hudson 1940).

Of special interest here is that Moffett's *Animalium Theatrum* was the first zoological work published in Britain. Regarding "this curious volume":

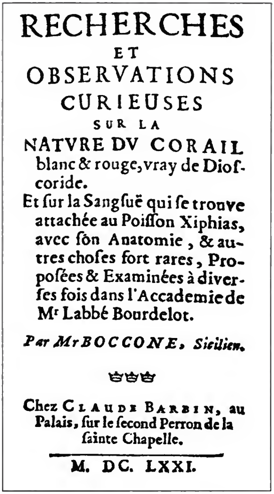
> In a work of so early a date, we must not look for any great departure from the prolixity and credulity of contemporary writers, or any thing beyond the rude classification of separate groups into distinct caputs or chapters; overloaded, as was the fashion of the age, with heavy details of common truths, and obscured by a want of precision and by absurd fables, handed down by Pliny to all succeeding compilers. The contents, however, are so far digested as that the winged and the apterous orders form the two principal divisions of the work; but then, in the latter, the author treats of caterpillars and grubs as if they were insects arrived at maturity, and of genuine worms as if they also were insects: the wood-cuts are many, but of great inferiority, even for the period of their execution; and they show how tardy the progress in England had yet been of the fine arts. . . . We may . . . infer that some taste for natural history had begun to show itself among the common people, when we find . . . in the year 1658 . . . an English translation . . . of the aforesaid Theatrum Insectorum of Dr. Mouffet. (Swainson 1834)

Cuvier said that Moffett was to insects what Gessner had been for quadrupeds and Rondelet to fishes, and that Moffett's treatise was the first with any pretensions of completion in that branch of zoology (Heltzel and Hudson 1940).

Paulo Silvio Boccone

24 April 1633–22 December 1704

In his "Research and Natural Observations," published in Paris, Paulo Silvio Boccone, from Palermo, Sicily, related how he was directed to some swordfish parasites at Messina (Boccone 1671). These, he said, were known to fishermen and scholars of Messina. He saw that the heads of the parasites were buried



RECHERCHES
ET
OBSERVATIONS
CURIEUSES
SUR LA
NATVRE DV CORAIL
blanc & rouge, vray de Dioſcoride.
Et ſur la Sangſuë qui ſe trouve attachée au Poiſſon Xiphias, avec ſon Anatomie, & autres choſes fort rares, Propoſées & Examinées à diverſes fois dans l'Accademie de Mr Labbé Bourdelot.

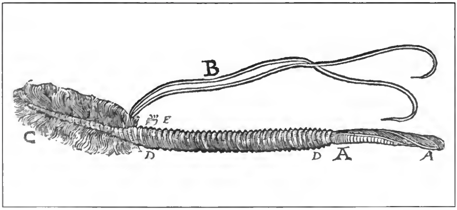
Par Mr BOCCONE, Sicilien.

Chez Claude Barbin, au Palais, ſur le ſecond Perron de la ſainte Chapelle.

M. DC. LXXI.

Title page of Boccone's essay "on the leech that is found attached to the fish Xiphias," a section within his larger* Recherches et Observations Naturelles *(1671).

into the fish, at places that could not be reached by fins. Boccone believed that these oddities were the same as Rondelet's and Gessner's species, which he incorrectly stated had not been illustrated by them. If he had seen their publications, he would have known that his specimens were very different. Boccone called his species a leech ("sangsue"), expanded in Latin to the leech-with-tail-feathered-on-both-sides ("Hirudo cauda utrinque pinnata").



"Leech-with-tail-feathered-on-both-sides," the first illustration of a pennellid copepod, parasitic on swordfish. From Boccone (1671).

Boccone's description and illustration were surprisingly good. The part he labeled AA was embedded in the flesh of the "Heron de mer" (swordfish, *Xiphias*). The filaments B, which we know are the egg strings, Boccone thought were merely for counterbalance, or in aid of attaching to rocks and plants while awaiting the host. Under a "good microscope," he could see that this parasite was in turn "tormented by a flea," denoted E (*Pediculus*). It is now known that these parasitic copepods are often hosts to numerous commensal barnacles; some later workers thought, erroneously, that the barnacles were pygmy male copepods. These episodes are reviewed by Wilson (1917a). Boccone noted that he had sent specimens in vials filled with brandy as far as Florence for examination.

Boccone's account was translated and published in the *Philosophical Transactions of the Royal Society* around 1700. Baird (1850) and others, from Boccone's figure, assign the parasites to today's genus *Pennella*. Boccone published several general natural history papers, with special interest in rocks and fossils; the last listed by Agassiz (1848) were from 1697. Agassiz's compilation was only of zoological and geological works; Swainson (1834) called Boccone the "famous Sicilian botanist." Jourdan (1820b) recorded a dozen Boccone papers on botany and mineralogy. Boccone (1671) himself said that "my principal profession is the study of botany," and that he taught occasionally at Abbot Bourdelot's Academy.

We are indebted to Sermonti Spada (1969) who compiled details of Boccone's life from several obscure sources. Although Boccone was born in Palermo, Sicily, his family had come from Savona, on the Gulf of Genoa. At that date, France was challenging the Spanish rule of both regions of Italy. Along with the usual theological courses of this period, Boccone included natural history, studying in particular at the botanical garden founded at Messina by a prominent Rome physician, himself a disciple of Andrea Cesalpino (1519–1603), Renaissance forerunner of Linnaeus.

Boccone also undertook extensive travel in Sicily, Italy, and much of Europe, and collected plants typical for each region (Jourdan 1820b). His observations extended to all natural phenomena, which he recorded with ardor, clarity, and critical analyses. He was thus one of the first to systematically deal with the flora of Europe.

S.R.I. ACADEMIÆ NATURÆ CURIOSORUM ARETÆUS. ÆT.XXXIX
MDCLXXXV
IOHANNES DE MURALTO TIGURIN. CHIRURGIÆ ET MEDICINÆ DOCTOR.

(left) *Johannes von Muralt (1645–1732), at age thirty-nine. Courtesy of the Wellcome Institute Library, London.*

(right) *Johannes von Muralt in 1691; "not just an entitled surgeon with the ability to contend, but instructing as Aesculapius, serving as Celsus, devoted as Paeon, and observant as Hippocrates." Courtesy of the National Library of Medicine.*

Boccone's best-known general work was the "Research and Natural Observations," which was translated from French into Dutch, Latin, and German. The work was presented as twenty-nine letters to illustrious scientific contemporaries. The letters discussed many subjects, including the eruption of Mt. Etna, medical problems, the anatomy and origin of corals, and mineral distribution and uses. Boccone's copepod was described in the fifth letter, to Laurens (Lorenzo) Bellini (1643-1704), professor at Pisa and discoverer of Bellini's ducts of the kidneys. Boccone's equally wide-ranging "Museum of Physics and of Experiments," published in Venice in 1697, examined the 1693 Sicilian earthquake, the medicines of Italy, the tarantula and the antidote for its bite, and the uses of sponges to stop bleeding.

In several botanical publications from 1672 to 1697, Boccone described nearly five hundred species. In acknowledgment of this early work, Linnaeus named the genus *Bocconia,* a member of the poppy family.

The Grand Duke of Tuscany made Boccone his court botanist and a lecturer at the University of Padua, in the Republic of Venice.

Boccone joined the Cistercian order (founded in 1089) at Florence in 1682, and he spent the last years of his life at its monastery of Santa Maria d'Altofonte in Parco, only five miles from Palermo. He was known in the brotherhood as "Silvio," the keeper of the woods. At the monastery, Brother Silvio dedicated himself to all aspects of plant culture and toward improving applications for the microscope. He died there in 1704.

Boccone was elected an honorary member of the Academia Naturae Curiosorum in 1696, where he chose the name "Pliny," in response to their custom (Jourdan 1820b). This venerable academy, founded in 1652 (Carus 1872, Garrison 1914, Cole 1944), will figure in the lives of several of our subjects, including the following.

Johannes von Muralt

? 1645-September 1732

Another species of parasitic copepod was noted in 1682 by Johannes von Muralt, or Muraltus, in his "Examen anatomicum Mustelae fluviatilus," published in the second-ten (Decuria II) of the patriarchal Nuremberg journal *Miscellanea Academiae Caesareo-Leopoldinae Naturae Curiosorum sive Ephemeridum Medico Physicarum Germanicarum.* While dissecting the shark (*Mustela fluviatilus*), Muralt said that he found this "insect" fixed into and hanging from its eye. Since it was so firmly inserted, he believed that it must have blinded the fish. Wilson (1917a) and Kabata (1979) said that this was *Tripaphylum musteli* (van Beneden, 1851), a sphyriid siphonostome.

Muralt was of Italian descent but was born in Zurich and died there. He had studied medicine in Germany, Holland, France, and England (Oxford). He obtained his doctorate in Leiden in 1668, under Franciscus Sylvius (1614–1672), the first to demonstrate the significance of tubercular lung nodules. Muralt returned to Basel, Switzerland, in 1671 and took a leading part in the important medical and scientific revival in Switzerland in the seventeenth century. He pioneered better education and surgical techniques, and declared that every surgeon must also be a refined physician. He was against the common separation of the two arts (Hirsch 1886).

In 1685, Muralt was elected to the Academia Naturae Curiosorum and contributed many papers on comparative anatomy to its proceedings. In this circle, it was fashionable to have a pseudonym, and his was "Aretaeus" (Cole 1944). His fellow academician, "Helianthus," commissioned "a true image of the countenance of the animated, clever, and popular Aretaeus" at age thirty-nine.

Comparative anatomical studies were the fashion among the academicians. Noteworthy dissections were done of insects, fish, birds, and mammals. According to Cole (1944), Muralt was the best of these anatomists.

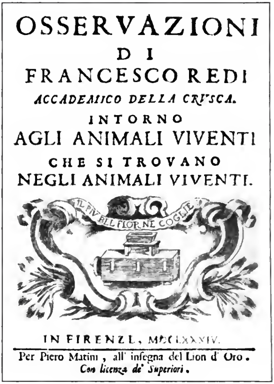
Agassiz (1853) recorded nineteen Muralt publications between 1677 and 1718, on physics as well as zoology; in the latter field, especially of fish and insects. Hagen (1862) recorded thirty-three papers on insects.

Muralt published several significant medical books. Like others of his time, he was superstitious, believing that the Devil played no small role in the physical ills of mankind (Hirsch 1886).

Francesco Redi

18 February 1626–1 March 1698

It was not unusual that Francesco Redi combined his talents and interests as a physician and naturalist, but it was out of the ordinary that he found fame as a poet and man of letters as well. As a naturalist, Redi is remembered best for his creative attacks on the old concept of spontaneous generation. The miraculous appearance of living forms in infusions of hay, or in putrid matter, or as internal parasites had been noted from Aristotle's time. Redi, in 1668, using what we would now call "controls," presented the first scientific analysis of this principle. He proved that if living material is excluded, no living things would later arise. Many scholars of the period disbelieved and criticized Redi for this, especially since his particular observations, on flies, did not include microscopic animals. The whole concept was still being argued two centuries later in the work of Louis Pasteur (1822–1895). Oddly enough, even Redi maintained that spontaneous generation was possible, as seen in plant galls and in intestinal worms (Gottdenker 1979).

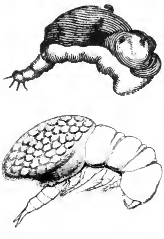


OSSERVAZIONI
DI
FRANCESCO REDI
ACCADEMICO DELLA CRVSCA.
INTORNO
AGLI ANIMALI VIVENTI
CHE SI TROVANO
NEGLI ANIMALI VIVENTI.

IL PIU BEL FIOR NE COGLIE

IN FIRENZE, MDCLXXXIV.
Per Piero Matini, all' inſegna del Lion d' Oro.
Con licenza de' Superiori.

Title page of Redi's "Observations" (1684).



A commensal copepod taken from its tunicate host by Redi (1684; Pl. 21, fig. 7), compared to the widespread Doropygus pulex *Thorell, 1859, as drawn by Canu (1892; Pl. 8, fig. 12).*

Redi was born of a noble family in Arezzo, Italy, southeast of Florence. He studied medicine and philosophy at Florence and Pisa. He made his home afterward in Florence, where he was physician to two successive Dukes of Tuscany. It is recorded that he died in Pisa (Cole 1944).

Entomologists lay strong claims to Redi because of his many excellent early microscopic dissections and accurate drawings of insect anatomy (Beier 1973). But Redi worked also on the larger crustaceans, worms, mollusks, several fishes, an owl, chick embryology, and an ascidian (*Microcosmos* sp.) (Cole 1944). He left many good observations on the protective coloration and mimicry in stick insects.

Redi's (1684) extensive "Observations concerning the living animals that one finds within living animals" holds the unmistakable account and figure of a commensal copepod from the above-mentioned

Francesco Redi (1626–1698). Courtesy of the Wellcome Institute Library, London; signature from Adler (1989).

ascidian, or tunicate. This was believed by Canu (1892) to be a *Doropygus* species, a cyclopoid, and Redi's drawing compares rather well with the exquisite drawing by Canu two centuries later. Redi said that these little animals, no larger than a small grain of wheat, hold on within the cavity of the tunicate's trunk. He found them in every tunicate examined during the first halves of several consecutive years. When living, he said, they were black or grayish brown stained with black. When exposed to the air, they turned vivid red. They were neithet hard nor covered with a carapace. Instead, they were soft, and when squeezed between one's fingers they burst readily, and were broken up without any resistance. He often found five or six in one tunicate, but there could be any number up to a dozen. Redi noted that they would remain alive for up to three days within a tunicate that had been detached from the rocks. He viewed these "little worms" under a lens, and wondered if they were born within the host or if they merely sought refuge there. He also puzzled over their method of feeding. It would be nearly another two hundred years before it became known that these copepods obtain food that the host has filtered out of the water, and that new hosts are colonized by way of free-swimming juvenile stages.

One of Redi's (1684) plates had three figures of an unmistakable cladoceran, "microscopic animalcules from stagnant water."

Redi's "Observations" were republished in 1708 and in various forms of collected works, such as the nine volumes printed in Milan from 1809 to 1811. These collections would include Redi's poetry, a long ode to "Bacchus in Tuscany," and a book of sonnets from 1685 (Jourdan 1824).

Redi was a founding member of the short-lived Accademia della Crusca (1657–1667), one of the fitst scientific societies, the result, rather than the cause, of fervent activity in the natural sciences (Cole 1944, Gottdenker 1979). The vignette on the title page of Redi's "Observations" is the device of the Accademia, a machine whose purpose eludes me; perhaps it is a roller-mill. Their motto, "To gather more fine flowers," is a noble sentiment.

* * *

Baird (1850) and Brian (1906) mentioned a few passages by some even more obscure seventeenth-century naturalists who added little to the oft-repeated comments of Aristotle.

Jan Swammerdam

12 February 1637–17 February 1680

Of the near-microscopic and free-living Crustacea, the earliest to be revealed to science was a cladoceran, a close relative of copepods. Called then "water-fleas," cladocerans were first seen under the increasingly popular microscope and described by the Dutchman, Jan Swammerdam. Swammerdam is better remembered for being the first to observe red blood-cells, in 1658 (Garrison 1914). Following contemporary classification, Swammerdam included the water flea in a 1669 work titled *Historia Insectorum Generalis,* published in Utrecht, Holland (Baird 1850). Even though this was not a copepod, homage should be paid here to Swammerdam because his water flea was first in a long line that in the sense of that period included copepods, and so was a standard of comparison for many new accounts. Most of Swammerdam's work appeared after his short life but proved his genius as an anatomist of invertebrates and a master of comparative zoology (Nordenskiold 1928, Cole 1944, Beier 1973). There is no known authentic portrait of Swammerdam.

It was no accident that these and other early records came from Holland. At that time, and long afterward, Holland was the most cultured country of the Western world, and with Holland's maritime trade, one of the tichest. Not only did Holland's own scientists contribute where no others did, their reputation attract-

STEPH BLANCARDUS
PH. et MED. Doct. etc. Et. XXXVI.

(left) ***Stephan Blankaart (1650–1702) at age thirty-six. Courtesy of the Wellcome Institute Library, London.***

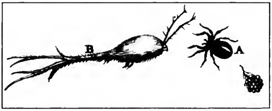
(right) ***Stephan Blankaart at age fifty, from his 1717*** Lexicon Medicum Renovatum. ***Courtesy of the Wellcome Institute Library, London.***

ed innumerable students from other parts of Europe. Some of these, we will see, would return to embed their own new knowledge in their homelands.

Besides the relative obscurity of copepods, there were other reasons why there were so few early accounts:

> The difficulty of preserving them obliges the naturalist to seek them in their secret lurking places, the fresh-water ponds and ditches, and the little pools in the rocks on the sea-shore, where they are chiefly to be found, or on the fishes to which they adhere as parasites, and to study them, as it were, upon the spot, with the aid of his microscope. (Baird 1850)

The inconvenience and complications of working with live or fresh specimens, stemming from the lack of a suitable preservation medium, were significant. Most preserved materials before then were dried, an ineffective procedure for copepods. Alcohol in glass vessels was introduced in 1662 as a preservative for vertebrates, and thereafter adapted to invertebrates of many kinds (Cole 1944). Made possible by the techniques of preservation, the establishment and growth of museums from this time aided the study of all organisms (Cole 1944); many who later contributed to our knowledge of copepods were inseparable from their associated museums, benefitting from and enhancing that association.



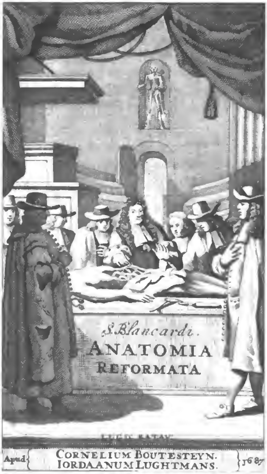
The "water-louse from the cistern" (B), the first illustration of a free-living copepod. From Blankaart (1688).

Stephan Blankaart

24 October 1650–23 February 1702

It was toward the end of the seventeenth century that the microscope's window opened upon the free-living copepods. That branch of our study had its scientific beginnings with Stephan Blankaart, a doctor of philosophy and medicine practicing in Amsterdam. In 1679, Blankaart compiled a *Lexicon Medicum* that had other editions as late as 1748 (Dobell 1958). Agassiz (1848), under Blancaert, listed three papers on human anatomy published between 1676 and 1688. Jourdan's (1820a) annotated bibliography included twenty Blankaart contributions to medicine.

Blankaart (1688) published what he called a "Theater of caterpillars, worms, grubs, and little flying animals," to bring to the attention of diverse readers some of the strange animals he had seen. He declared that his observations contained nothing other


S. Blancardi.
ANATOMIA
REFORMATA
LUGD. BATAV.
Apud
CORNELIUM BOUTESTEYN.
IORDAANUM LUGHTMANS.
1687

(left) ***Stephan Blankaart demonstrating in the anatomy hall, 1687. Courtesy of the Wellcome Institute Library, London.***

(right) ***Frontispiece from Stephan Blankaart's "Theater of caterpillars, worms, grubs, and little flying animals" (1688).***

than the contemplation of God's wonderful works. Blankaart first studied humanities at Breda, converting to medicine at Amsterdam, and finally receiving his doctorate at the University of Franeker (Holland, 1585 to 1811) (Jourdan 1820a). Hagen (1863) stated that Blankaart was born in Middelburg (Holland) in 1650 and died in 1702. His "Theater" was dedicated to his young wife Cornelia, as well as to his father "the noble and most learned gentleman Nicolaus Blancardus [1624–1703], writer of maritime history, Greek writings and language, etc." (Blankaart 1688). The frontispiece presumably depicts the author displaying choice animals to an astonished gentleman.

A short chapter, "On the water-louse in the cistern," became a milestone in our history not for any great insight, but because it is the starting point for the other principal lineage of copepods. Blankaart noted that Swammerdam had also brought attention to a small animal named the water-louse, but that this was different. It was found in some rainwater pumped from a cistern; by placing the animals under a "microscope," that is to say a magnifying glass, he was able to see some details, both in form and movement. The animal had a very long tail, split at the end into two parts. The tail especially was set around with many shaggy hairs. The lower part of the body had a large number of sharp feet. The forward part of the body had two long, hairy finlets with which the animal would swim. Some of the animals were reddish, others were whiter, but both kinds were translucent. They swam with jerky forward thrusts, then swimming ceased and they sank with their head held upright;

This vignette represents a well similar to those in which these animals are frequently found.

then they swam again as before. If the water was stirred, they became still, and sank to the bottom.

Blankaart brought his magnifying glass to the weed-mats themselves and could see no differences from what he had observed before. He watched some of these animals in a bottle of water. He claims to have found them not only through the entire summer and fall, but even through the winter. Blankaart kept many of these "lice" in a fish container, to which a tench was added and seen to eat them. The animal, said Blankaart, is indicated on his Tab. XIII by the letter B. From a later time, this figure would have best been forgotten. However, seeing that nothing came before, and thousands since, it is a remarkable record. The figure, poor as it is, with the fairly good description, points to what we would now call a *Cyclops* species.

Antony van Leeuwenhoek

24 October 1632–26 August 1723

Were it not for Blankaart, we would have much more to say about this period's premier observer of the smallest things: Antony van Leeuwenhoek. Leeuwenhoek, another Netherlander, saw life that had never yet been seen by anyone, and left behind clear observations and numerous intriguing illustrations on a variety of subjects from minerals to whales. He discovered bacteria and protozoa, but of copepods, he was not the first, and there is not much. Leeuwenhoek knew Swammerdam, and in 1675 observed the latter's "water-fleas," now known to be cladocerans.

Leeuwenhoek, about whom we know a great deal, was the quintessential scientist: intuitive, curious, resourceful, and energetic. He stood apart from others because of his understanding of the gulf between observation and inference. Those things he did discover led him steadily into new directions of questions and answers.

The self-taught Leeuwenhoek never wrote a scientific paper or a book; all of his observations were disclosed in letters, hundreds of them, in Dutch, to like-minded men throughout Europe. Many were sent to the Royal Society of London, where he was elected a Fellow in 1680. His first studies were described when he was forty years old; his last at age ninety-one. Although his reports generated considerable interest, Leeuwenhoek's special ability in grinding lenses and working with minute specimens discouraged matching endeavors. Particular attention was brought to bear on Leeuwenhoek's simple microscopes. In spite of requests, he never recorded their specifications or manufacture, although he delighted in showing many to visitors. Ultimately he bequeathed an extensive set to the Royal Society, which, after assessment, sadly disappeared. The strongest of these had a 200x magnification (Dobell 1958).

Onderdanige Dienaar

Antonij van Leeuwenhoek

The plain delight in Leeuwenhoek's diversions shows through in his innocent terminology (Dobell 1923). He called his subjects *beesjes, cleijne schepsels,* or *dierkens* ("beasties, little creatures, or little animals").

By today's light, Leeuwenhoek's observations were crude and unfinished. To his contemporaries, his accounts were so revolutionary and so strange that many were not believed, and it is at this level that Leeuwenhoek should be judged (Cole 1944).

Gentleman in the Country

A Leeuwenhoek letter to the Royal Society in 1699 briefly described and illustrated a freshwater "insect" that can also be identified as a *Cyclops* species. He observed large variations between specimens of different ages but did not mention specific transformations (Baird 1850). Another Leeuwenhoek letter

Antony van Leeuwenhoek (1632–1723). Courtesy of the National Library of Medicine; signature from Dobell (1958).

(from 1703), in the *Philosophical Transactions* (No. 283), in which he briefly described some rotifers and protozoans, precipitated a letter from a "Gentleman in the Country" (1703). This nameless writer's main point was to improve on Leeuwenhoek's descriptions of the *Animalcula,* although he admitted to being "a little mortified to see . . . an account of a Creature which I thought I had a sort of Propriety in, and of which I had made a Draught, with a design to present you . . . with a rarity, which I believed no body had met with but my self." After augmenting Leeuwenhoek's rotifer record, this correspondent took the opportunity to add descriptions of other animals that had come under his "best Glasses." The story is properly relayed in his own words, typical of the times:

> I think it no mean instance of Providence, that many kinds of Water Insects . . . are furnished with such Organs about their Head, the vibration of which, brings a constant current towards their Mouths, and with that, Food for their Support, otherwise they would be starv'd for want of Nourishment.
>
> If you ask what Insects those are, . . . I must tell you they are of divers[e] sorts, and that I have observ'd no small variety in the water of our Ditches, [including] perfect Shell-fish, both Crustaceous and Testaceous, and have been so pleas'd with the Beauty of some of them, that I have kept them many weeks by me, as an agreeable entertainment for such as are curious. . . . Having preserv'd two tolerable Scetches of two sorts of the Crustaceous kind, I venture to send them to you. . . . [The figure] shews them as they lye with their back towards you in a swimming posture, but the Members and Legs on the other side are so various, and so much more curiously form'd than those of Lobsters and Shrimps, that I despair'd of giving any tolerable representation of them in any other position. These are about the same size, the biggest being rather less than a very small Flea, and the least a little bigger than a Mite, but all are Breeders, and carry their spawn at their Tayl, . . . [the first] in two Bags (one on each side) which are fasten'd about the 5th joynt, and the other in a single Bag or Film under the Tayl, and I have often seen these Bags broken, and the Spawn (which is globular and large in the proportion to the Fish) scatter'd through the Water. There is also among these a third sort of the same kind, not less elegant, tho far less in bulk, which is shap'd more like a Shrimp, and carries its Spawn like that, but I could never make any Figure of it worth preserving; . . . all these three species (as also some other Water-Insects) are certainly monoculous, and have their Eye exactly in the middle of their head, and I could never with my utmost application find so much as a dividing Line in it. Some of them, especially in some Waters, are dark and cloudy, but they are generally so transparent, that through the Shell I can see the peristaltick motion quite through their whole length, and a constant pulsation of a part, which I guess is the Heart, but I could never discover any course of Blood in them (nor even in Shrimps themselves which are as large as some thousands of these) tho I have seen it plainly in Creatures a little bigger, *viz.,* the smallest new hatch'd Spyders, and in that Water Insect which is describ'd and pictur'd (tho not accurately) by *Swammerdam,* under the (very improper) name of *Pulex aquaticus.* But this is of the Testaceous kind, of which I have seen a greater variety (and not less curious) than of the Crustaceous. (Gentleman in the Country 1703)

The term "Testaceous" refers to "shelled," or covered with a test; that is, a somewhat yielding shell. The contrasting term, "Crustaceous," refers to a crust, or hard unyielding shell.

In these two three-hundred-year-old paragraphs we have a much improved description of Blankaart's cyclops of fifteen years before, as well as the first descriptions of calanoid and harpacticoid copepods. Not unworthy of a Gentleman in the Country. Baird (1850) thought that the calanoid was *Diaptomus castor* and the harpacticoid was *Canthocamptus minutus.*

Dobell (1958) made an extraordinary effort to identify this author, but without success: "every clue has proved unavailing, and I fear that 'The Gentleman in the Country' covered up his tracks on purpose—in order to remain anonymous for ever." Dobell's interest was in the protozoans, but similar praise should be given to this unknown pioneer's copepod commentary: "light-hearted and conversational, which shows nevertheless remarkable insight and ability. The pictures were far ahead of anything previously published, and are sufficient alone to establish their draughtsman as Eldest Son of the Father of Protozoology."

* * *

A diligent search of the multitudinous insect papers from the seventeenth century would certainly reveal other references to free-living copepods. However, the level of detail would likely be comparable to that in Blankaart, Leeuwenhoek, and the Gentleman in the Country.

4

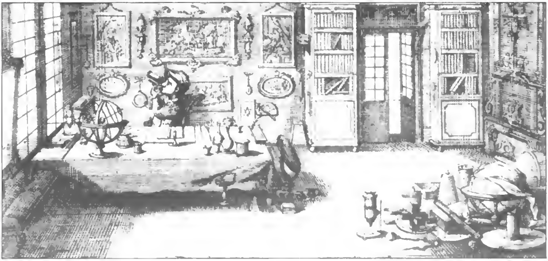
NATURE'S TREASURY

> All we have yet discovered is but a trifle, in comparison of what still lies hid in the great treasury of Nature.
>
> —ANTONY VAN LEEUWENHOEK, *Letter to Robert Hooke*, MAY 20, 1679

> Having one only son, I am anxious to improve him to my power, and although I had sets of very good glasses, yet that art being improved, you'll extreamely oblige me to give a line of the best glasses now made for the discovery of insects in water.
>
> —*Letter to Sir Hans Sloane*, 1715

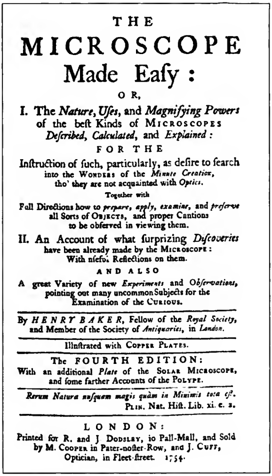
BEFORE THE OUTBREAK of political revolution toward the end of the 1700s, there was a long period of science seeking theories and order. With very few exceptions, "biologists" were taxonomists; this is not surprising, because of the fundamental nature of the work and the infinite, untouched field.

Throughout the eighteenth century, copepods became regular features in a number of zoological records. It is the intention of the present treatise to trace this history as an independent discipline. Some of these early reports were based on grand expeditions, sent to the uttermost parts of the world by government decree; these voyages are the stuff of many books, some yet to be. With respect to copepods, most observers of this era had only single and minor claims to fame. Baird (1850) lists several in his synonymies. Even if all zoological work before Linnaeus's 1758 *Systema Naturae* is not "officially" ignored, that date would have been an important watershed because of the Linnaean impact



A scholar looking into a microscope, as drawn by Louis Joblot (1645–1723) for his 1718 Observations d'Histoire Naturelle faites avec le Microscope. *Courtesy of the National Library of Medicine.*

HENRY BAKER,
Fellow of the Royal
and of the Society for the
Arts, Manufactures and
Author of "The Microscope made easy"
"Employment for the Microscope" and other Works.
Born May
Published by J Nichols



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Printed for R. and J. DODSLEY, in Pall-Mall, and Sold
by M. COOPER in Pater-noſter-Row, and J. CUFF,
Optician, in Fleet-ſtreet. 1754.

(left) *Henry Baker (1698–1774). Courtesy of the Wellcome Institute Library, London.*

(right) *Title page of the fourth edition of Baker's* Microscope Made Easy *(1754).*

and succeeding rapid developments. However, the literature from the 1700s is mostly rare and difficult to access. Biographical material is even harder to locate. In any case, there are not many significant eighteenth-century copepod references before 1758.

Louis Joblot

ca. 6 August 1645–27 April 1723

The first of these was by Louis Joblot, who had more in common with Leeuwenhoek than just the year of death. In many ways he was a kind of French Leeuwenhoek, except that Joblot had a formal education and formal academic attachments. Joblot was born at Bar-le-Duc (Meuse); his early studies were of mathematics and natural science. He had a long career as Professor of Mathematics at the Royal Academy of Painting and Sculpture. Joblot attained a place in science with an obscure and rare 1718 publication, *Observations d'Histoire Naturelle faites avec le Microscope,* containing descriptions of many aquatic "insects." Some of these were protozoans (Dobell 1923), but Baird (1850) said Joblot's Plate 14, Figure C, is *Cyclops quadricornis,* an inadequately defined copepod species from a later time.

Joblot's "Natural History" was reprinted in 1754, long after his death, and his work is usually, and incorrectly, credited from the later time. Joblot is best recalled for early views against spontaneous generation (Boyer 1894, Dobell 1923, Gottdenker 1979). In spite of Leeuwenhoek's assertions (from 1675), and Joblot's and others, against spontaneous generation, this gross error persisted at least for a century, and even by the 1830s there remained a few zoologists who believed in spontaneous generation with respect to lower animals. (One of these was Rudolphi, Nordmann's honored professor.)

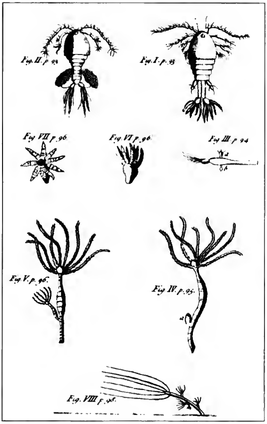
Henry Baker

8 May 1698–25 November 1774

The next Englishman to record a copepod was Henry Baker, who said, reading a paper before the Royal Society in 1744, that he had found an "eye-sucker" on sprat. This was similar to the species that had caught Muralt's attention in the previous century. The society published Baker's paper in *Philosophical Transactions* to give, as quoted from the title page of the journal, "some account of the present undertakings, studies, and labours, of the ingenious in many considerable parts of the world." Baker (1746) said that his newly discovered "sea-insect" was attached headfirst into the fish's eye. In spite of a poor illustration, Baird (1850) was inclined to equate this with *Lerneonema sprattae* (Sowerby, 1806), a species now placed in the genus *Lernaeenicus* Lesueur, 1824, where it remains to this day as *Lernaeenicus sprattae* (Sowerby, 1806) (see Wilson 1917a, Kabata 1979).

Baker acknowledged imperfections in the portrayal:

> As the Insects, whence I take this Description, were dead and dry, it cannot possibly be so exact and particular; and is more liable to Mistake, than if they had been living. But I hope it may serve to give some Idea of this odd Creature, till a better can be obtained from some curious Observer, who may get a Sight of it alive. I am, with the utmost Respect, Sir, Your most obedient humble Servant. (Baker 1746)



Cyclops sp., described as "Crustaceous Animalcules . . . in a swimming Posture, with their Backs towards the Eye," as well as some freshwater polyps. From Baker (1754).

Baker's science paralleled Leeuwenhoek's and Joblot's, with forceful notations attributing luminous bacteria as well as intestinal worms in man and fish to natural transfers of "animalcules," rather than to the popular spontaneous generation. By a curious coincidence, Baker, a Fellow of the Royal Society, was the one who carefully evaluated Leeuwenhoek's microscopes for the society (Dobell 1958).

Baker was a persistent proponent of the microscope and wrote semipopular books on the subject. One was his 1743 *Microscope Made Easy,* which illustrated some *Cyclops* species as "Crustaceous Animalcules":

> We may find in the Waters of our Ditches several Species both of Testaceous and Crustaceous *Animalcules:* two of the latter sort, which are most remarkable, are shewn (Plate IX. Fig. I. and II.) in a swimming Posture, with their Backs towards the Eye. Their Legs are somewhat like Shrimps or Lobsters, but of a much more curious Structure. They are less than a very small Flea, but are all Breeders, and carry their Spawn either under their Tail, or in two seeming [from Baker's footnote: *Arcan. Nat.* Tom. II. Epist. 121. Philosoph. Transact. Numb. 288.] Bags hanging from their Sides, as in Fig. II. These Bags may sometimes be observed broken, and the Spawn (consisting of Globules very large in Proportion to the Creature) scatter'd about the Water. There is also a third Sort, as beautiful as the foregoing, but not near so large; its Shape more resembles a Shrimp, and it carries its Spawn as the Shrimp does. These three Species of *Animalcules* appear to have only one Eye, and that placed in the middle of the Forehead, without so much as the least Trace of even a dividing Line. They are often to be found so transparent, that the Motion of their Bowels is seen distinctly by the *Microscope,* together with a regular Pulsation in a little Part, which therefore we may suppose to be the Heart. (Baker 1754)

Another popular book was Baker's 1753 *Employment for the Microscope.* Both books had reprintings and other editions, on the continent as well as in England.

Baker was the recipient of the Royal Society's Copley Medal, in 1744, for microscopic experiments. He also invented a system of instruction for deaf-mutes and authored philosophical poetry. In 1729,

(left) ***August Johann Roesel von Rosenhof (1705–1759). From Adler (1989).***

Baker married Sophia, youngest daughter of Daniel Defoe (1659?–1731), author of *Robinson Crusoe.* Baker was involved in joint literary ventures with his famous father-in-law (*Webster's* 1960).

August Johann Roesel von Rosenhof

30 March 1705–27 March 1759

A typical pre-Linnaean copepod observation was that of August Johann Roesel von Rosenhof. Roesel was born in Augustenburg, near Arnstadt (south of Erfurt, in southeastern Germany), in the old state of Thuringia, but he spent most of his rather short life in Nuremberg. He was the son of an engraver and court steward. Roesel was schooled in Arnstadt until age thirteen. His talents for animal illustration had already been noticed by his family and the local nobility. He was sent to the art academy in Nuremberg where he specialized in engraving and miniature painting. This met with such approval that Roesel easily paid his way, even to the extent of allowing a trip to Copenhagen in 1726. He rejected a lifetime employment offer there and returned to Nuremberg in 1728 (Hess 1889).

Roesel then established himself as a miniature painter and blossomed as a naturalist. By 1740, he sold by subscription a bimonthly colored plate and text, the *Monatliche Insectenbelustigungen.* Roesel engraved his own drawings, which are counted among the most beautiful and accurate of the eighteenth century (Nordenskiold 1928, Tuxen 1973). From 1746, these productions were combined and published as *Der Insectenbelustigungen,* totaling four volumes up to 1761. In the third volume, Roesel illustrated a water flea, recognizable as a *Cyclops* species, as the substrate for hydrae, which nearly cover the whole body (Baird 1850).

Of interest is the practical classification scheme that J. C. Fabricius (1778) outlined from Roesel's *Insectenbelustigungen* of 1746:

I. Terrestrial
II. Aquatica
  1. undergo metamorphosis
    a. larvae with 6 legs
    b. larvae with 16 legs
    c. larvae without legs
  2. without metamorphosis
    a. 6 feet
    b. 8 feet
    c. 10 feet
    d. 14 feet
    e. no feet (Worms)

Presumably the copepods (all free-living "insects") would have been placed under 2a or 2b.

Roesel is also remembered for his 1758 *Historia Naturalis Ranarum* (with foreword by the Swiss naturalist/poet Albrecht von Haller), with its exquisite hand-colored drawings of frogs and toads throughout their development (Dance 1978). Roesel had a good-natured spirit ("gemuthlich," in the older spelling) and was happiest when observing nature. The smallest and most unpretentious creatures pleased him most. In 1755, he was the first to describe and illustrate an amoeba and other well-known protozoans (Cole 1926). To Roesel, these were further proof of the wisdom of the natural order and its Creator.

Pehr Loefling

20 January 1729–22 February 1756

Although this author now falls slightly outside of the copepod realm, he has earned a place in this narrative. Pehr Loefling, from the backwoods of Sweden, was called by Linnaeus his most adored and promising pupil; to Loefling, Linnaeus entrusted the tutoring of his son. At Linnaeus's recommendation, the government of Spain commissioned Loefling to conduct a botanical survey of the Pyrenean Peninsula. This turned out so well for Spain that Loefling was asked to expand his work to Spanish

America. This commission did not turn out so well for Loefling, who was soon killed by the climate and tropical diseases (Nordenskiold 1928, Blunt 1971). There is a rich assortment of Loefling's notes and drawings from South America (Rydén 1957), but unfortunately no portrait from anywhere.

In 1751, Loefling published "*Monoculus cauda foliacea plana* descriptus," in the *Acta Societatis Regiae Scientiarum Uppsaliensis.* This species, found by Loefling on Swedish pike and perch, and called by the natives "Abbor-lus" and "Gadd-lus," is the same as the later Linnaean *Argulus foliaceus,* a close relative of copepods. Although argulids are not now considered true copepods, they are near enough for us to honor Loefling as the first martyr to our science. He would not be the last. Loefling published another paper, in 1752, on a coral; a larger work, on his journeys to the Spanish lands of Europe and America, was completed by Linnaeus in 1768.

Nils Gissler

20 February 1715–19 November 1771

Nils Gissler, the first physician in the true Norrland, was born in Gissjo, Torp, in the Vasternorrland Province of east central Sweden. He died in Harnosand, the provincial capital, about one hundred km east on the Gulf of Bothnia. Gissler's parents were poor farmers; consequently, Gissler's education was hard-won. The parish clergymen gave him his first instruction, and by 1729 Gissler was a pupil at the gymnasium in Harnosand. He left there in 1733 to study at Uppsala University (Nordgren 1925, Lindroth 1967a).

The question must now be raised regarding a possible Linnaean role in Gissler's early education. Linnaeus had finished his famous Lapland journey and was still a student in 1733. Even though Linnaeus was an independent instructor in botany and mineralogy, it was not likely that he and Gissler had any meaningful contact up to that time. After the fall term, Linnaeus left Uppsala until March 1734, staying only briefly before setting out on another exploration. Linnaeus returned to Uppsala only to take a theological examination, a requirement for a student seeking a passport to study abroad (Blunt 1971). He was soon off to Holland. When Linnaeus returned to Sweden, it was to Stockholm as a physician in 1738 (Forsstrand 1915). He did not return to Uppsala until October 1741, as a new professor.

Gissler originally intended to pursue theological studies at the university, but he ended with an unusually diverse program. His need to support his studies necessitated frequent interruptions and a prolonged sequence. He became absorbed in philosophical writings and devoted himself to mathematics and chemistry; he also studied astronomy under Anders Celsius (1701–1744), who described the centigrade thermometer in 1742.

According to Gissler's own surviving records, to cure his serious headaches, he began to dabble in medical studies. By the end of the 1730s, he was employed as a records keeper ("informator") for the court apothecary in Stockholm. The well-organized Gissler trained himself as an apothecary with the court's considerable natural history cabinet and pharmaceutical laboratory. He also studied anatomy and medical works, and his life's pattern was set. More important, he then became acquainted with Linnaeus and with his encouragement followed him to Uppsala University in 1741 (Nordgren 1925, Lindroth 1967a).

Now Gissler was committed to medicine, and he became a disciple of Linnaeus and the anatomy professor Nils Rosen von Rosenstein (1706–1773) (Nordgren 1925). Gissler successfully defended his pharmaceutical dissertation in the spring of 1744, and he was awarded the M.D. in December.

Gissler then obtained a position as gymnasium lecturer in logic and natural history in Harnosand. That post had been combined in the previous year with that of provincial physician for upper Vasternorrland. Gissler struggled vigorously to replace the earlier useless official health service within his enormous district. By 1762, Gissler was obliged to limit himself to two subdistricts. He was ardent even as the gymnasium instructor and gave lectures in a newly built botanical garden.

Patients came from near and far as Gissler's reputation as a medical oracle increased. Many sufferers were treated without cost. It was said that he administered to everything from injured limbs to weak minds, and was not averse to adapting innovations such as electric shocks and small-pox inoculations (Lindroth 1957).

Gissler learned the basics of medical practice from a friend and corresponded at length on epidemics, cures, and local medicinal plants with Abraham Back (1713–1795), Stockholm's court physician and Linnaeus's best friend (Lindroth 1967a, Blunt 1971).

In spite of his rigorous duties, Gissler found time for a broad scientific activity. He was a member of the Swedish Academy of Sciences from 1748, and he published twenty-eight essays on various subjects in its *Handlingar* (Transactions) beginning in 1747. He corresponded regularly with the academy's secretary, a friend from student days. His interests covered a wide range of topics in economics and nature: he wrote about dry lakes, fish and salmon ("laxfiske"), birds, beavers, husbandry of pearl mussels, and health care. His observations on salmon-spawning migrations into rivers were not new, but Gissler provided many details for salmon natural history and economics, stimulating new fisheries work in the Baltic Sea.

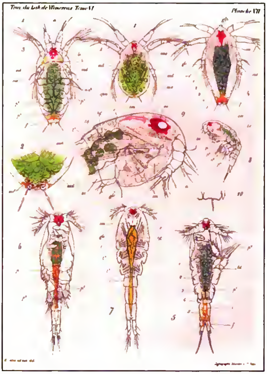
Gissler described and illustrated the "lax-lusen" (salmon-louse) from the gills and mouth of a salmon; this memoir also appeared in the "Transactions of the Royal Swedish Academy of Sciences" (Gissler 1751). Gissler named this parasite *Pediculus salmonis*; we will see in Chapter 5 how this copepod was snatched from the pre-Linnaean void and given perpetual life by the master. Bruguiere (1791) and Berland and Margolis (1983) reproduced Gissler's plate, showing various views of the female copepod.

On behalf of the Royal Swedish Academy, Gissler made far-northern astronomical observations with respect to the transit of Venus in 1761 and 1769. (The latter coincided with similar measurements taken for the Royal Society of London by James Cook and Joseph Banks in Tahiti.)

Before he could credibly collect the astronomical data, Gissler had to familiarize himself with the whole field of meteorology. He worked according to a large text and corresponded with meteorologists, and he delivered his still-surviving records to the academy. He even remarked in a letter to a friend that he enjoyed meteorology most of all, saying

> I study sunsets, sun, moon, storms, earthquakes, lightning and thunder, sea-mist, northern lights, rainbows, falling stars, etc.... Dear Brother, send me some new books on meteorology. (Lindroth 1967b)

Gissler was known to be a pleasant and charming man. He also played several musical instruments; the inventory of his estate included a harpsichord, piano, and cello. However, his driven spirit also had a dark streak of anguish and melancholy. From 1751, Gissler had serious mental upsets that he spoke of as painful attacks and hallucinations. Gissler attributed these to the Devil in thoughts related in a remarkable surviving manuscript (Nordgren 1925). This is a clinically exact handbook of demonology, describing Satan throwing fire and flames and "a pack of Hell-hounds" upon him. Gissler's only surviving son became mentally ill (Lindroth 1967a). Perhaps Gissler's own imbalances made him all the more interested and sympathetic toward the psychiatric problems of others.



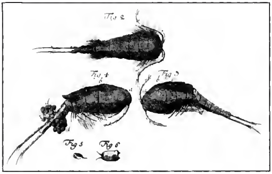
Metamorphosis of Doropygus gibber *Thorell, 1859, a commensal copepod from tunicates. The newly hatched nauplius is shown in Figure 1. From Canu (1892).*

The many-sided and hard-working Gissler was widely respected as a practicing physician and humanitarian, burdens and accomplishments enough without his scientific contributions. When Gissler died, Abraham Back praised him as an idolized physician with a tender and unselfish heart (Lindroth 1967a).

Johan Christian Lange

6 December 1717–27 May 1776

The first Danish work to originally describe a copepod was that of Johan Christian Lange. Lange, a physician, produced a little book with the long title "Science of the Natural Waters, together with a basic investigation of the waters, which are found in Copenhagen and its vicinity, and which mostly are utilized for all kinds of benefits for its inhabitants. Finally there is information on the question: Which water is the best?" (Lange 1756). Lange in particular surveyed Copenhagen's drinking water. He published drawings of three "water-fleas" (a *Cyclops*

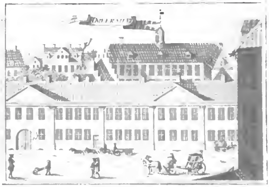


"Water-fleas" (free-living copepods) and the first account and illustration of their larvae. From Lange (1756).

species), one of which was carrying egg sacs. Lange also described some other water fleas (Cladocera), like those, he said, that were discussed by Swammerdam, and some true insects. Lange's little animals had been "drawn from life" by O. H. de Lode, who signed the plates. As advice to his readers, Lange suggested that they use a bag of hat felt to filter the "fish" (all the small creatures) and plants from the water before drinking, or, if desired, they could "enjoy a soup of them if the water is boiled" (Dahl 1941).

Through the courtesy of Torben Wolff, I obtained a copy of the relevant parts of this rare book from the Copenhagen University Library. Lange left here a notable copepodological landmark: he was the first to describe the newly hatched copepod larval form, much later given the name "nauplius." Unfortunately, this work was overlooked by most who followed, and the usual credit for this discovery was given to Lange's countryman O. F. Müller. The major difference, however, between the two observations, besides the twenty-year gap, was that Müller believed his specimens were independent adult forms of two new genera (*Nauplius* and *Amymone*). Lange, to his everlasting fame, described the larval stages as they hatched before his eyes from the copepod's eggs. He also illustrated some details not found in other publications from this time, and gave a quaint description of the "water-fleas" in his Plate I, Figs. 2–7, as they

> hop around in the water with strong movements. They have a single horn [i.e., antenna, *one* per side]; their eye (a) is light-red. Their outer skin is constructed of many segments; they have several legs along their mid-region. The posterior end is distinctly cleft at the very end. A short distance from the head, along the center of the body, runs a canal (b), seen as a wide stripe, splitting into two canals posteriorly, and from the front to the back, it incessantly moves, with an interior yellow mass. Upon their backs there are two round bodies (c) that do not move from that spot, and that look like two small drops of blood. The remaining part of their bodies is whitish except for black stripes. On [Figure] No. 3 has been noted the canal (d) from where the small eggs come out, which are seen on both sides of No. 4 and which appear reddish or bluish. When these animals move themselves upward in the water, the legs stretch out, and when the legs flex it is in coordination with the body with the tail bent into a half-circle. They carry their small eggs for a fairly long time, as shown in the fourth figure, which afterward fall off in one clump, while they make a circular movement in the water, until at last it separates from the other, and one sees that, from them come small animals, such as are shown in No. 5, which in their growth become as Figure No. 6 and which then strive, however weak and slowly to practice the same movements, as their parents. In No. 2 one sees it lying on its stomach, in No. 3 and No. 4 from the side. These last views are of the female, and the first is of the male. No. 7 is of their natural size and typical position. This kind comes in fairly close agreement with that, sketched by Baker [from Lange's footnote: compare with Baker, Microscope]. (Lange 1756)



The University of Copenhagen in 1765. From Wolff (1979).

This was an unrivaled effort in spite of the figure of the nauplius stage, which charitably looked like a cross between an adult form and the earliest larva. The figure of a copepodid stage (older juvenile) was a bit medieval, but considering everything, not so bad. Lange's was the best description of a free-living copepod for nearly a generation.

Viets (1955) recorded Lange's birth in the Imperial Free City (until 1815) of Lübeck, now Germany. Lange was an apothecary in Germany, Sweden, and Denmark. In 1754, he surfaced as a physician in Copenhagen, where he died in 1776.

Erik Pontoppidan

24 August 1698–20 December 1764

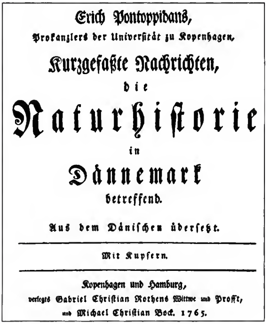
Another Dane, but one who made a much greater and lasting impact in natural history, was Erik Pontoppidan. Although Pontoppidan's copepod coverage was in the barely visible rank, because of its context in his comprehensive two-volume "Norwegian Natural History" of 1751–1753, it was significant and a stimulus to further inquiry. Pontoppidan gave an interesting description of a salmon parasite, probably *Lepeophtheirus salmonis* (Krøyer, 1837), as the salmon entering fresh water apparently tried to rid themselves of that "greenish vermin" (Berland and Margolis 1983).

Pontoppidan was an eminent man in his day and, like others we will encounter on the copepod path, was trained as a theologian; in 1738, he became Professor of Theology at the University of Copenhagen. He was bishop of Bergen from 1747 until 1755, when he was named vice-chancellor of the University of Copenhagen, a post he retained until his death (Dahl 1941, Broch 1954). Another of Pontoppidan's accomplishments was a multivolumed "Atlas of Denmark," from 1763 to 1767.

The "Norwegian Natural History," published in Copenhagen, was distinctly modern in its concept, although Pontoppidan was more like the old encyclopedists, trying to squeeze in every fact without having the time or resources to verify most. In this respect, he could be called Norway's Pliny; he even cites Pliny as the authority on some geographical matters. The "Natural History" was popular and was soon translated into German and English. A German version was a one-volume "Brief Accounts concerning the Natural History of Denmark," using most of the original illustrations. There were chapters on geography, climate, weather, geology, fresh water and salt water, trees, plants, crops, wild and domestic animals, land- and water-birds, fish and fisheries, and "all kinds of creeping and fluttering animals, as otters, snakes, worms, snails, and mussels, with a list of the insects" (Pontoppidan 1765). It is the "insects" that brought us to this book. However, Pontoppidan, or perhaps the translator, arranged all of the species according to Linnaeus's system, making this condensed version of the "Natural History" post-Linnaean. Even though the copepods are mentioned now, they can best be understood in a post-Linnaean context, after Linnaeus, his system, and his exceptional influence are reviewed.

In explaining the classification used in the abridged German version of his "Natural History," Pontoppidan pointed to Linnaeus's famous tenth edition of *Systema Naturae,* to Linnaeus's "Fauna of Sweden," and to Doctor Georg Tycho Holms, author of *Flora Danica,* who "had spent some years at the

(left) *Erik Pontoppidan (1698–1764). From Broch (1954).*



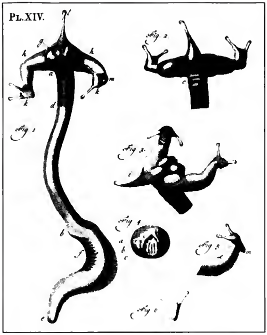
Erich Pontoppidans,
Prokanzlers der Univerſität zu Kopenhagen,
Kurzgefaßte Nachrichten,
die
Naturhiſtorie
in
Dännemark
betreffend.

Aus dem Däniſchen überſetzt.

Mit Kupfern.

Kopenhagen und Hamburg,
verlegts Gabriel Chriſtian Rothens Wittwe und Proft,
und Michael Chriſtian Bock. 1765.

(right) *Title page of the 1765 German translation and abridgement of Pontoppidan's "Natural History of Denmark."*



(left) ***The well-described although pre-Linnaean*** **Cephalopus, *or "Head-Foot," a parasite of codfish. From Nozeman 1757.***

(right) ***Remarkable natural caverns and rocks characteristic of the Danish island of Bornholm, in the Baltic Sea. From Pontoppidan (1765).***

home of the famous Ritter Linnaeus" (referring to the titled Linnaeus). Within the Insecta Aptera were *Podura aquatica,* said to be the water fleas described and figured by Lange. This was probably a *Cyclops* species: "because it is so small, it is difficult to describe; but it should not be overlooked. They hop about by means of their appendages and cleft posterior" (Pontoppidan 1765). Pontoppidan frankly admitted that his knowledge here did not extend to each and every species, a second of which was *Monoculus pulex*; this was another of Lange's species, probably the cladoceran. A third and final species, listed without comment, was *Monoculus quadricornis,* soon to be revealed as a term for a number of ill-defined copepod species.

Posterity has given unfair weight to Pontoppidan's chapter (not repeated in the German version) on "Marine Monsters," like the kraken. There was a grain of truth in the kraken, it being the authentic giant squid, magnified from medieval records and myths:

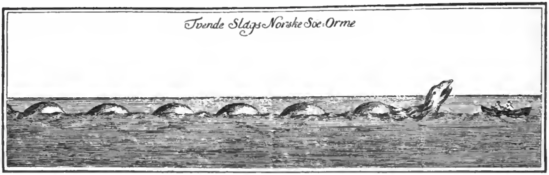
In respect that your Grace has commissioned
  a Kraken,
You will please be inform'd that they seldom
  are taken;
It is January two years, the Zetland folks say,
Since they saw the last Kraken in Scalloway bay.

—Sir Walter Scott, *Postscriptum,* 1814

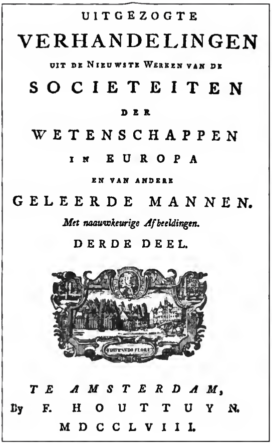
Cornelius Nozeman

15 August 1721–22 July 1786

Above all a respected theologian, Cornelius Nozeman also secured a place in Dutch zoology through his pioneer works on birds (Brouwer 1954). And like his follower, Martinus Houttuyn (see Chapter 6), Nozeman had wide zoological interests and left his mark in many animal groups. Born in Amsterdam, by 1744 Nozeman was a clergyman, first in Alkmaar, then Haarlem, and finally Rotterdam. Throughout his life as an esteemed man of the Remonstrant Church, Nozeman in his spare time pursued the questions What has been written about the natural history of our father-



Eyewitness account of Pontoppidan's great northern sea-serpent, or kraken. From Gould (1930).



UITGEZOGTE
VERHANDELINGEN
UIT DE NIEUWSTE WERKEN VAN DE
SOCIETEITEN
DER
WETENSCHAPPEN
IN EUROPA
EN VAN ANDERE
GELEERDE MANNEN.
Met naauwkeurige Afbeeldingen.
DERDE DEEL.

TE AMSTERDAM,
By F. HOUTTUYN.
MDCCLVIII.

(left) ***The title page of the journal in which Nozeman (1758) published an additional description of the parasitic copepod*** **Cephalopus.**

(right) ***Cornelius Nozeman (1721–1786). From Brouwer (1954).***

land? and What is needed? Nozeman had a special fascination with birds. In 1770, he began the five-volume series on birds of the Netherlands, *Nederlandsche Vogelen,* that was taken over by others (including Houttuyn) and not finished until 1829. He himself collected material for his large and famous natural history cabinet.

From 1749 to 1760, Nozeman was in Haarlem where he participated in and encouraged its strong Academy of Science. He strengthened Dutch natural history studies by supporting the "Edited Transactions of Recent Contributions from the Science Societies of Europe and of other Learned Men," ten volumes published in Amsterdam from 1756 to 1765. It is in the earliest volumes of this journal that we find Nozeman's impressive work on copepods and other marine subjects (Agassiz 1848, van der Aa 1852).

Nozeman's (1757) first copepod publication was in the form of a letter to his like-minded compatriot Martinus Houttuyn, about "a recently discovered water-insect," a parasite from codfish. Nozeman showed some righteous ambiguity by calling his specimens "insects," yet classifying them as zoophytes. He noticed these parasites among discarded pieces of codfish heads. After rinsing them with water he examined them more carefully, comparing them to grubs and maggots that live deeply under the skin of cattle or reindeer and that finally burst forth as adult horseflies. He asked why it would be any stranger to find these insects coming from codfish heads, since there were "insects" seen also in codfish livers. He also thought there was some relation to his newly discovered creatures and the presumably poisonous "little crabs" (pea crabs, pinnotherids) from mussels and oysters in summer. He said that a well-known and attentive physician from North Holland had informed him that people who ate codfish heads in late spring had symptoms similar to those who ate bad mussels or oysters. The same terrible and fatal consequences befell them all. Nozeman believed that some comparable sea insect's eggs infected these harvested fish and shellfish. Of course, Nozeman was off the mark here, but his willingness to take a broad view was commendable.

Nozeman was unable to find a reference to "our insect" in any of the literature likely to deal with this. He also noted its absence from sea legends or local wisdom. Its apparent newness convinced him that he should describe it in the journal.

When held in the hand, the animalcule was found to be cartilaginous and elastic from its head to its

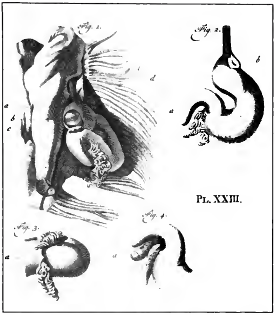


Fig. 1.
Fig. 2.
a
b
c
d
Pl. XXIII.
Fig. 3.
Fig. 4.

Nozeman's (1758) additional figures of Cephalopus, *now known as* Lernaeocera branchialis. *From Linnaeus, 1767.*

neck. The lower part was soft and globular, like an outstretched intestine. He gave a detailed description of the mouth area and said that it was like that of a sucking insect. The creature was translucent, as the common earthworm, and was wrinkled on the main body as he illustrated. Except for the head and "feet," which were blackish, the whole insect was brownish, yet bright, polished, and glimmering. When stretched out, it measured one and three-quarters of a Rhineland inch (total length 45.5 mm).

Nozeman was certain that this new form did not belong to the tribe of creeping worms, as Linnaeus had defined in an early *Systema Naturae,* because of the lack of limbs in such worms. Nor was this a shelled or shell-bearing worm, in spite of parts of it reminding him of a goose barnacle; here he was closer than he could have imagined. After dismissing these possibilities, Nozeman settled on "the so-called Class *Zoophyta,* that is, the *Plantlike Worms,* identical to that named by Mr. C. Linnaeus" (Nozeman 1757). For Nozeman, the determining characteristic of this group was that

> they have a naked body, *provided with limbs.* But exactly where to place our insect is by no means so easy; it cannot be judged to belong to a single one of the genera which Mr. Linnaeus assigned to the Class of Plantlike Worms. It is no wonder. The great Linnaeus himself never pretended that he knew all of the genera of the *Zoophyta* in the whole animal kingdom (as the general title *Systema Naturae* might indicate), or that there could be no more than *thirteen* families of Plantlike Worms. Everyday we could create a genus for a kind of discovered creature which had previously escaped our notice and therefore remained unknown. Is not the *System of Nature* in truth a work that never reaches an end? (Nozeman 1757)

Nozeman wanted to give an appropriate name to his present "Water-Insect" and settled on the "Head-Foot," or *Cephalopus.* In systematics it is usually the first paper published that obtains priority for new names, but, ironically, by publishing too soon, Nozeman's pre-Linnaean description was invalid. In this case, if Nozeman's publication had been delayed until after 1 January 1758 (the date assigned to Linnaeus's tenth edition), the genus *Cephalopus* could have entered the copepod catalog. (After 1930, a new genus name had to be associated with a species name to be acceptable.) However, even Nozeman's use of this picturesque name in 1758 did not ensure its endorsement by the post-Linnaean structure.

Although Nozeman (1757) failed the first nomenclatural test, he had a second chance to establish his parasitic copepod in the light of the Linnaean Year 1758. This was his "Further Observations about the Insect named Head-Foot." Nozeman said that this *Cephalopus* represented the same species as in the earlier paper; instead of finding them scattered among cut-up fish fragments, he traced the parasites to their attachment on the fish's gills. In Nozeman's (correct) view, the parasite lived on the fish's blood. The creatures were the same color as the gills. Nozeman was surprised when he could not find even the smallest openings in this new animal.

Nozeman gave considerable attention to the egg strings, which he at first thought were parts of an intestine. These, when pulled out, could extend to nine inches. He said that he accidentally observed that the Head-Foot was an egg-laying creature, "with external spawn, like many other aquatic animals." He placed a headless specimen on a piece of glass in water and picked at it daily for seven days. The egg clusters became disorganized, and eventually under a magnifying glass he could see the tiny eggs themselves, "as small as sand grains, looking like a gooey clump of cooked shellfish spawn" (Nozeman 1758). He preserved whole specimens and eggs in alcohol.

This copepod eventually and independently received the name *Lernaeocera branchialis* (Linnaeus, 1767). The obscurity of the journal doomed Nozeman's little Head-Foot at its second appearance. Life is not fair, and apparently it never was. Still, Nozeman's were the best descriptions of a parasitic copepod to that time, and there was none better for about seventy years.

Nozeman was puzzled over how these animals might reproduce, not knowing of the males, while

> in the meantime, the codfish is miserable! by putting up with such visitors as this wonderful animal. If the codfish feels the company of this pest, it would obtain no relief short of death. (Nozeman 1758)

Perhaps the learned and God-fearing Pastor Nozeman derived a moral from this theme for a sermon to enlighten his flock.

* * *

During the eighteenth century it was accepted by scholars that inconspicuous animals were not contemptible, but repaid with abundant interest their conscientious study. The first copepods soon to reach the light of official zoology represented the outermost forms of the copepod spectrum: the archetypal free-living species and the most bizarre parasites. So odd were the latter that they languished for nearly a century in a taxonomic dustbin. The free-living forms were recognized at the outset for the crustaceans-as-insects that they were. We have seen that several species from both groups were reported vaguely from various localities up to Linnaeus's time, but in his precedent-setting work of 1758 only six were acknowledged and thereby gained first entry into our science.

5

THE PRINCE OF NATURALISTS

> It is an easy task for the student of the present era to point out defects in the method of the master who has to plan the way, and who succeeded in making it level and easy to his followers.
>
> —GEORGE JOHNSTON, *A History of the British Zoophytes*

THE ROOTS OF zoological classification, as we saw in a preceding chapter, are firmly set in classical times. Aristotle's teacher, Plato (429–347 B.C.), professed a system of ideals that remains an important part of biology; that is, every horse is but an imperfect likeness of the ideal horse, which in turn is perfect and unchanging. The notion of "species," in contrast to the individual, arose from this ideal. Plato also recognized the next higher category, the genus, a grouping of similar species (Nordenskiold 1928; Mayr, Linsley, and Usinger 1953).

Carl Linnaeus

23 May 1707–10 January 1778

(right) ***Carl Linnaeus (1707–1778) in his Lapland field clothes, 1732. From Forsstrand (1915).***

Much has been written about Carl Linnaeus, a most worthy man. Indeed, so much is known about him, and so far-reaching was his work and impact, that his life resists condensation. Linnaeus's father was a Lutheran clergyman, and his childhood toys were flowers in his father's respectable garden. Crucial points were Linnaeus's long apprenticeship in book and field, his European travels and acquaintances, and his trial schemes in botany and zoology. Linnaeus's first brief attempt at categorizing all living creatures was the premier edition of *Systema Naturae,* fourteen pages published in Leiden in 1735. Linnaeus's *Species Plantarum* (1753) and *Genera Plantarum* (1754) are the recognized starting points for systematic botany, just as the tenth edition (1758) of his *Systema Naturae* is the "official" starting date for zoological nomenclature. These dates for Linnaeus's natural lists are so important in taxonomy that the whole subject is divided into pre-Linnaean and post-Linnaean. Even Linnaeus's own genus and species names and systems before these dates are "pre-Linnaean," and unless he used the names again in the definitive edition, or after, they have no status. The last edition of *Systema Naturae* published in Linnaeus's lifetime was the twelfth (1766–1768), in three volumes of twenty-three hundred pages.

Linnaeus was early attracted to Holland. Although the political balances were changing, Holland was still a rich and enlightened country, with all the world open to its merchant fleet. Many wealthy Dutch had gardens and earnestly acquired new and exotic plants; some were good amateur naturalists, and some were patrons of the sciences. It was not by chance that Linnaeus chose Holland as a three-year base.

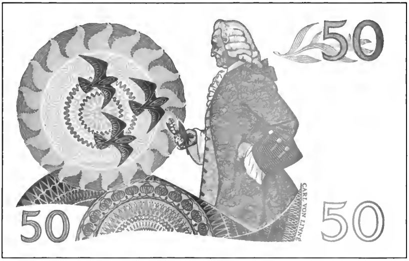
Linnaeus's arrival in Holland in 1735 was twelve years too late for Leeuwenhoek, but there is an interesting indirect personal and intellectual connection. From Linnaeus's earliest schooling he had read the books of Herman Boerhaave (1668–1738), Professor of Botany, Chemistry, and Medicine at Leiden (Nordenskiold 1928). Boerhaave, who is said to have been a whole medical faculty in himself, was well known to Leeuwenhoek, both in person and through Leeuwenhoek's renowned letters (Dobell 1958). No scientist visiting Holland would fail to meet with Boerhaave, and Linnaeus was no exception. In spite of getting off to a bad start (we would say now that Boerhaave felt that Linnaeus was too pushy), they became close friends. Boerhaave, who was a Fellow of the Royal Society, recognized greatness in the young Linnaeus and gave him boundless encouragement. Of Boerhaave's garden, which was actually an arboretum, Linnaeus said that it was paradise. A local physician and a student from Scotland offered to pay the printing costs for Linnaeus's first edition of *Systema Naturae,* and that is why this biological landmark was published in Leiden. Unfortunately it is a very rare book; only twenty-nine copies are known. Linnaeus dedicated his *Genera Plantarum* to Boerhaave, remaining close until the final death-bed scene (Blunt 1971). It is difficult for me to stop writing about such interesting persons, and we must soon get back to copepods after one or two more short detours.

In 1736 Linnaeus made a side trip to London especially to meet Sir Hans Sloane and to see Sloane's famed cabinet of natural history curios (Blunt 1971). Sloane (1660–1753) was an all-around naturalist and a living link to England's John Ray (1627?–1705), the first since Aristotle to attempt to work out animal and plant classifications based on natural relationships. Sloane succeeded Isaac Newton as president of the Royal Society (founded in 1662) and was physician to the king. He left the nation fifty thousand volumes, numerous manuscripts, and his justly celebrated collection, all of which became the nucleus of the British Museum (Brooks 1954).

When Linnaeus left Holland, he stayed one month in Paris. Linnaeus sought out the three de Jussieu botany brothers at the Jardin du Roi. He became particularly close to Bernard de Jussieu (1699–1777), whose nephew carried on the family tradition to 1836, and *his* son continued the dynasty to 1853; best known as a botanist, Bernard de Jussieu also had a broad knowledge of zoophytes (Miall 1912). Linnaeus also studied René Antoine Réaumur's (1683–1757) justly famous natural history cabinet (Blunt 1971).

In spite of staggering academic briberies from both Holland and France, Linnaeus returned to Sweden in 1738. The following year he was one of the founders of the Swedish Academy of Sciences. In 1741, Linnaeus took his lifelong post as Professor of Botany at Uppsala University, the first university in Sweden (founded in 1477). Atypical for any age, Linnaeus was honored in his own land and time. Sweden raised him to the nobility, which is the origin of his second name-form sometimes encountered: Carl von Linné. Sweden continues to honor him, and his portrait was carried until recently by countless Swedes on the back of the fifty-kronor banknote; on the front was Linnaeus's friend, the young King Gustav III. Linnaeus's portrait now appears on the one hundred-kronor note; a portrait

Swedish fifty-kronor note, ca. 1980, with portrait of Carl von Linné.



of Jenny Lind (1820–1887), the Swedish nightingale, now appears on the fifty-kronor banknote. An abstract honor is that, in zoology, only Linnaeus's name can be abbreviated (usually to "L.") as part of a complete scientific name. There is an imposing statue of Linnaeus in Chicago's Lincoln Park. And there are several "Linnean" societies around the world, furthering studies in natural history.

Of honors, Linnaeus himself was probably most pleased with the small and elegant circumpolar twin-flower, *Linnea borealis*; most contemporary portraits have him holding this, and it was prominent in his coat of arms. He was justly proud of his nearly two hundred students, attracted from afar, including America; at least twenty-three of his students became professors (Peattie 1938, Blunt 1971, Stafleu 1971). He called his students "apostles" and sent them to the far corners of the earth.

Linnaeus's modest estate, Hammarby, is a national monument and world shrine. Included in instructions to be opened after his death, Linnaeus had written to his wife: "If a tree dies, then plant another in its place" (Blunt 1971).

In 1784, Linnaeus's heirs sold his library, papers, and collections—to the lasting regret of Sweden—to a wealthy English naturalist, Sir James Edward Smith (1759–1828); they remain as international treasures in the care of the Linnean Society of London (Gage 1938).

Linnaeus, "the 'prince of naturalists,' as his followers loved to style him—from whose decision on all disputed points in natural history there was scarcely an admissible appeal . . . was a man not only of superior capacity and acquirements, of great sagacity, ready apprehension, and fruitful fancy, but he was also of a candid and liberal disposition" (Johnston 1847).

Carl Linnaeus (1707–1778). Portrait from Anon. (1893); signature from Jespersen (1946).

Car. Linnæus

Most early naturalists understood that common names for organisms varied by locality, language, temperament, and time. To eliminate some of this variability, Latin became an accepted "scientific" language. Even so, until Linnaeus, naturalists were inconsistent in the scientific names they applied to plants and animals. Many tried to combine names and descriptions, resulting in cumbersome polynomials. Some used one name, usually in the sense of a genus; others added a second, qualifying name. The binomial, with a genus and species name, became the standard, succinctly distinguishing both the general and the particular. Linnaeus was not the first to apply these, but he did it with unparalleled enthusiasm, naming or renaming in a useful hierarchy every creature of the known world. Even Linnaeus was not consistent until, for animals, the tenth edition of his *Systema Naturae*, in 1758. This momentous volume was designated by the International Congress of Zoology as the starting point of all zoological nomenclature. If Linnaeus had published in his native Swedish, rather than the then universal language of science (Latin), he and his work would be but a footnote. However, by 1800, virtually all zoologists were following the Linnaean system (Mayr, Linsley, and Usinger 1953).

Linnaeus arranged the animal kingdom into six classes: Mammalia (a Linnaean term), Aves, Amphibia, Pisces, Vermes, and Insecta. The last two classes held the invertebrates, and of these, Linnaeus gave most attention to the Insecta. These were reviewed in the first volume of the famous work (Linnaeus 1758).

The Linnaean Class Vermes was divided into several orders that represented most worms, soft mollusks (which included lernaeids), shelled mollusks, and the old Aristotelian zoophytes. Although Linnaeus placed the zoophytes in the animal kingdom, he seems to have otherwise abandoned them. George Johnston, after decades of study and seeing the zoophytes reduced group by group even in his lifetime, said of Linnaeus and his successors' treatment of zoophytes that

> were we to analyze the genera we should find, in almost every one of them, species which properly belong to a different class of animals, or whose characters are at variance with those assigned to the genus: but many of these misplacements were the almost necessary consequences of the then state of knowledge relative to the beings in question. (Johnston 1847)

The zoophyte category was formed not only because these puzzling animals generally resembled plants, but because they lacked obvious animal qualities. Zoophytes were

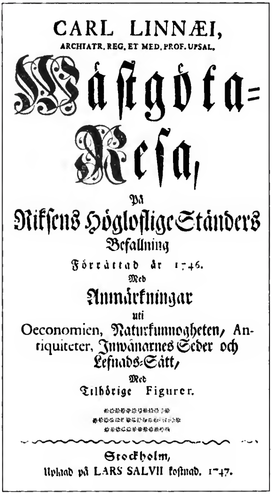
> unsusceptible of the volitions and passions which move and agitate higher entities.... The zoologists claimed none of them ... but left them without dispute to botanical writers; and if any of these, in reference to a very few zoophytes of the least arborescent in character, hazarded a whispered conjecture that they were wrongly classed, it died away in the utterance, and raised no echo to awaken further inquiry. (Johnston 1847)

The Linnaean Class Insecta was also subdivided into several orders, most of which are still acknowledged. The last order was Aptera, the "wingless insects," accommodating some insects, the spiders and their allies, and all the crustaceans except barnacles (which were mollusks then) and some parasitic copepods (which were soft mollusks and zoophytes). One must keep in mind that the total number of known (i.e., named) organisms was very small, so that what we now see as an enormous category held only a few genera and not many species.

All except one of the known species of free-living lower Crustacea were placed in a single genus, *Monoculus*. The exception was a brine shrimp (today's branchiopod), which was assigned to the genus *Cancer*. Both *Cancer* and *Monoculus* were of the Insecta Aptera.

The wonderful name *Monoculus* has long faded from zoological literature (Fox 1951). Linnaeus had recognized nine species, only one of which, *Monoculus quadricornis*, was a copepod. Although Linnaeus's brief description sufficed to separate *M. quadricornis* from other *Monoculus* species, it was far from sufficient to characterize a species against a backdrop of large numbers of similar free-living copepods. It is necessary to jump ahead in time to settle the fate of this first scientifically defined copepod. Müller (1776) thought that he observed this Linnaean species, but that a proper nomenclature required a new genus, which Müller designated *Cyclops*. This species would then be called *Cyclops quadricornis* (Linnaeus, 1758). Unfortunately, Müller's (1785) subsequent expanded description, with illustrations, led subsequent workers to believe that the species was a composite of several *Cyclops* species. Therefore, the name *Cyclops quadricornis* was ignored and the process essentially began anew. Schmeil (1892) suggested that *Cyclops quadricornis* might be the same as *Cyclops strenuus* Fischer, 1851, but he was unwilling to take that step. One cannot now be comfortable assigning *Cyclops quadricornis* (Linnaeus, 1758) to any accepted species name, nor would it simplify or clarify modern taxonomy. Instead, "this protean species" (Baird 1850) persists only as a monument to science's early observations on the common and abundant freshwater cyclopoids.

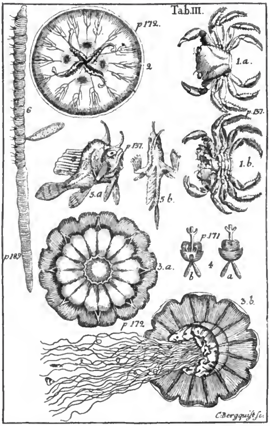
Müller (1785) gave a forthright and modern attempt to clarify the old *Monoculus quadricornis*, but



CARL LINNÆI,
ARCHIATR. REG. ET MED. PROF. UPSAL.
Wäſtgöta-
Reſa,
På
Rikſens Högloflige Ständers
Befallning
Förrättad år 1746.
Med
Anmärkningar
uti
Oeconomien, Naturkunnogheten, Antiquiteter, Inwånarnes Seder och
Lefnads-Sätt,
Med
Tilhörige Figurer.

Stockholm,
Uplagd på LARS SALVII koſtnad. 1747.

Title page of Linnaeus's Wastgota-Resa *(1747).*



Figures from Linnaeus (1747), including the parasitic copepod (as Vermes) Lernaea cauda duplici tereti *dorsal (Fig. 4a) and ventral (Fig. 4b), as well as other marine animals.*

Lapp fishermen in an 1802 scene. From Ilomets (1976).

this was not treated well by subsequent viewers. Today, such a situation would likely have been handled in another way. The next revisor would have access to museum specimens ("types") that give objectivity to newly described species. From those specimens, necessary details could be added to the first description, retaining the name. If no types were available, another effort would be made in the type-locality to collect new material from which "neotypes" would be designated. Failing all that, it is possible to make a reasonable effort to match a newly observed specimen to the species in question, and to amend the description, and in so doing it virtually becomes that species. This is an oversimplified version of a complex process, but it is unlikely today that a new species and new name would be ignored into oblivion.

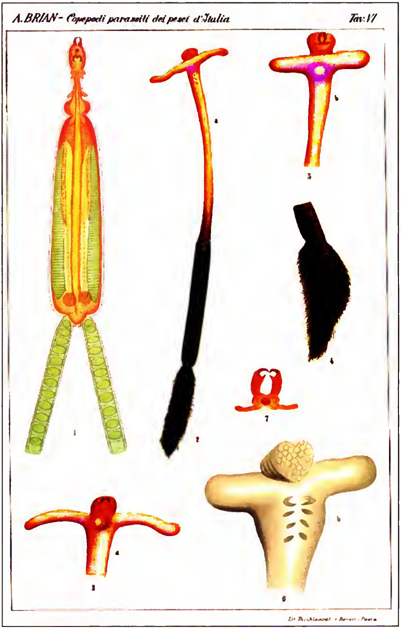
A second *Monoculus* species, *M. foliaceus,* now known as *Argulus foliaceus* (Linnaeus, 1758), was for many years included with copepods. Now, however, the freshwater and marine argulids, which are external parasites of fishes, are classed apart from copepods (as the Branchiura) and will be mentioned only occasionally in this treatise. These old generic names echo of heroes and history, and I mourn the loss to copepodology of both Monoculus and Argulus. The refutation of Monoculus, the one-eyed, was somewhat made good by the creation of Cyclops, the Homeric monster of the same morphology. Argulus was derived at the opposite extreme, being the diminutive of Argus, the hundred-eyed guardian of Io, daughter of a king and beloved of Jupiter. Io swam across the sea between Italy and Greece, giving us the Ionian Sea, while Mercury disposed of Argus.

In Linnaeus's classic work, five of the other seven *Monoculus* species were crustaceans: a notostracan, two cladocerans, an ostracod, and a conchostracan. The remaining two species were the king crab (a close relative of spiders) and a pteropod mollusk (Fox 1951).

Celebrated collectively with *Monoculus quadricornis* (later *Cyclops*), the other first copepods mentioned by Linnaeus in the tenth edition of *Systema Naturae* were parasitic and assigned to the Vermes, both Mollusca and Zoophyta. Linnaeus found one of these odd parasites on a Crucian carp, and he described it in his *Fauna Suecica* ("The Fauna of Sweden") in 1746, giving it the genus name *Lernaea* (the mythical swampy abode of the nine-headed hydra slain by Hercules) and the species epitaph *tentaculis quatuor* (with four tentacles). Lernaeids include some of the most destructive parasites of freshwater fishes. The wormlike adult female has its head buried immovably into the flesh of the fish, usually near the dorsal fin, with the posterior part of the body and the egg strings hanging free in the water. Large (about an inch in length) and conspicuous, they were doubtless well known to the old Scandinavian fishermen. Linnaeus's record was the start of a vast literature on *Lernaea,* since nearly all early parasitic copepods were placed in a family based on this genus. The following year, Linnaeus (1747) described and illustrated a second species, *Lernaea cauda duplici tereti* (with rounded double tail) from a West Gothland (also Sweden) saltwater fish, genus *Gadus,* but neither copepod name is official since ultimately even Linnaeus is held to the international rules. Leigh-Sharpe and Oakley (1927) reproduced Linnaeus's 1747 figure.

Linnaeus (1758) certified his priority hold on these parasitic copepods when they were listed in that famous tenth edition, under Vermes Mollusca. He renamed the first species *Lernaea cyprinacea* (the lernaeid from carp); therefore, this became not only the first official lernaeid and the type of the genus (because listed first), but this species bears the oldest surviving genus name for any copepod (see the frontispiece in this volume). This cornerstone copepod endures, under all rules and unencumbered by further taxonomic contortions, as *Lernaea cyprinacea* L., 1758, the type genus and species of the cyclopoid family Lernaeidae. The second species, from West Gothland, was renamed *Lernaea asellina* and is today placed among the Chondracanthidae (poecilostomes), as the only species of the genus *Lernentoma* de Blainville, 1822 (see Kabata 1979). A third lernaeid was the rescued *Pediculus salmonis* from the paper by Gissler (1751), called by Linnaeus *Lernaea salmonea.* This became the type species of the genus *Salmincola* Wilson, 1915, as *Salmincola salmoneus* (Linnaeus, 1758), now in the Lernaeopodidae (siphonostomes) (Berland and Margolis 1983). Thus, these last two species were seen by posterity to be only distantly related to the first lernaeid.

Linnaeus (1758) mentioned two final species, both marine, of parasitic copepods, under Vermes Zoophyta. As with the lernaeids, he completely misunderstood the nature of these beasts. Because of their feathery, leathery form, he placed them with the sea pens, in the genus *Pennatula.* This name is enshrined in the coelenterate order Pennatulacea, where the genus is still found, unburdened by parasitic copepods. The first of these Linnaean copepod species was *Pennatula filosa,* taken from the Mediterranean swordfish. The second was *Pennatula sagitta,* found on the sargassum fish. Subsequent investigators mentioned that Linnaeus's host notations were about the only useful characteristics he provided (Stebbing 1905). Since Linnaeus's time, other features have been defined, and both species are valid. Oken (1815), without knowing their true nature, but


A. BRIAN - Copepodi parassiti dei pesci d'Italia
Tav: VI
1
2
3
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7
a
b

Pennella crassicornis *(Figs. 2–7), a parasite of the bottle-nosed whale, and the related* Peniculus fistula *(Fig. 1). From Brian (1906).*

seeing that these parasites were not as "other" coral-like polyps, proposed the appropriate name *Pennella,* the "little feather," for the copepods. Linnaeus's species names are retained, so that the two species are now *Pennella sagitta* (Linnaeus, 1758), the type species of the genus, and *Pennella filosa* (Linnaeus, 1758), both now in the siphonostome family Pennellidae (see Kabata 1979).

The honors for the first officially registered copepods, even though most had yet to be recognized as copepods, must therefore go to these six: the composite species *Cyclops quadricornis* (Linnaeus, 1758), whatever it might be; *Lernaea cyprinacea* Linnaeus, 1758; *Lernentoma asellina* (Linnaeus, 1758); *Salmincola salmoneus* (Linnaeus, 1758); *Pennella sagitta* (Linnaeus, 1758); and *Pennella filosa* (Linnaeus, 1758). If this humble beginning is magnified to encompass the entire animal and plant kingdoms, the reader need have no illusions about the significance of Linnaeus's work.

A final, unexpected, and perhaps bizarre honor to Linnaeus could be derived from the modern convention of "types." The type specimen is that which the author had before him, knew best, and believed represents the new species. The species *Homo sapiens* was first described taxonomically by Linnaeus in 1758; by definition, the type specimen would be Linnaeus himself, more or less preserved in Uppsala Cathedral.

6

LINNAEAN LEGACY

> Pray do not imagine that those who make the most noise are the only inhabitants of the field.
>
> —Edmund Burke, *Reflections of the Revolution in France*

LINNAEUS AS A YOUNG MAN apprenticed on several arduous and lonely travels; his natural history survey into Lapland is considered the first of its kind. In later life he had many opportunities to explore exotic places, but he chose instead to send his students. In several cases afterward, he helped interpret the collections. The consequent death of a high number of promising students in his service was an understandable and lifelong burden. We have already mentioned the truncated career of Pehr Loefling.

One may speculate on what might have been accomplished if Linnaeus himself had gone to Asia or America, but most agree that the effect was greater because he sent his "apostles," as he called them (Peattie 1938).

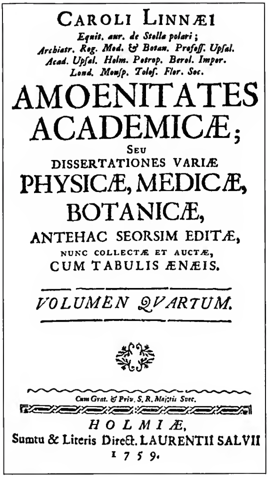
Of the immortal company of Linnaeus's far-ranging students should be mentioned Daniel Carl Solander (1736–1782), a Swede who was a naturalist on Cook's voyage around the world on the *Endeavour* (1768–1771), which started the long and distinguished English tradition combining naval affairs and science; Carl Peter Thunberg (1743–1828), sent to South Africa and Java, the first European naturalist to see the flowers of Japan's forbidden Mount Fuji, and eventual successor to Linnaeus at Uppsala; Peter Kalm (1715–1779), a Finnish Swede renowned for botanical surveys of North America, well remembered in the prized mountain laurel *Kalmia*; and Peter Forskål, who died dressed as an Arab and surrounded by vultures on the Arabian Peninsula. None of these four Linnaean students has a copepod connection, but copepods will be seen in the work of Linnaeus's student Fabricius.

Peter Forskål

11 January 1732–11 July 1763

It will be instructive to spend a few lines on Peter Forskål's journey, famous for its tragic consequences, because it depicts so well the organizational, logistical, personal, and scientific challenges faced by one of the earliest large-scale, state-supported research expeditions (Hansen 1962). Forskål, a Swede from Helsingfors in the service of Denmark, described many new invertebrates from the open Mediterranean Sea and, after an overland trek to Suez, through the Red Sea to the southern tip of the Arabian Peninsula, where he died of malaria in Yemen. Of the six incompatible scientists, only one survived to publish Forskål's descriptions, all in the familiar Linnaean system, in the classic *Descriptiones animalium* (Forskål 1775).

Among Forskål's Insecta, there were numerous crabs and shrimps, and the first description of the curious and now well-known pelagic amphipod *Phronima sedentaria*, placed by Forskål in the genus *Cancer*. That there were no copepods was probably due to the lack of good preservation techniques and the exceptionally harsh treatment the collections received on their journey back to science



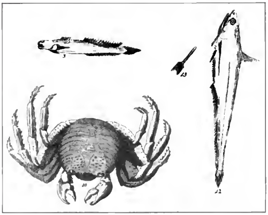
CAROLI LINNÆI
Equit. aur. de Stella polari;
Archiatr. Reg. Med. & Botan. Profeſſ. Upſal.
Acad. Upſal. Holm. Petrop. Berol. Imper.
Lond. Monſp. Toloſ. Flor. Soc.
AMOENITATES
ACADEMICÆ;
SEU
DISSERTATIONES VARIÆ
PHYSICÆ, MEDICÆ,
BOTANICÆ,
ANTEHAC SEORSIM EDITÆ,
NUNC COLLECTÆ ET AUCTÆ,
CUM TABULIS ÆNEIS.

VOLUMEN QVARTUM.

Cum Grat. & Priv. S. R. Maj:tis Svec.

HOLMIÆ,
Sumtu & Literis Direct. LAURENTII SALVII
1759.

Title page from Linnaeus's "Academic Favorites" (Odhelius 1759).



Terminal section of Pennatula *(*Pennella*)* sagitta *(Fig. 13), the first copepod reported from Asia, together with a crab and two fishes drawn by Odhelius (1759).*

(Wolff 1968). That anything survived is an accounted miracle, yet a large number of specimens remain, mostly type material. Surprisingly, this remnant includes the *Phronima,* still inside its pelagic-tunicate abode.

Similar in concept, but generally more successful in effect, a large number of "national" expeditions followed throughout the next two centuries, adding an infinitude of copepods to our collected knowledge.

Johan Lorens Odhelius

3 March 1737–23 August 1816

To return the narrative to the post-Linnaean copepod theme, few could step in front of Johan Lorens Odhelius, who presented a paper on 23 December 1754 on some new or rare organisms collected for Linnaeus in the Far East. The collection had been made on behalf of Magnus Lagerström (1691–1759), the director of the Swedish East India Company (Stafleu 1971). The Swedish East India Company (founded in 1731) was an important facilitator in the travels of Linnaeus's students (Lindroth 1957, Rydén 1957). Lagerström, a member of the Swedish Academy of Sciences, was an enthusiast for all natural history and ethnographic studies, not just for commercial interests. The collections were named "Chinensia Lagerströmiana," even though they were made in Madagascar, the East Indies, and other places on the way to China proper. Linnaeus himself, and several students, published reports on this material after 1754, and many well-known marine animals, from *Physalia* to *Nautilus,* were represented (Lindroth 1957).

Linnaeus took advantage of Lagerström's opportunities and sent out the first of several apostles in 1746. At least one student made four trips. One of these collectors was "the useful but morose" Pehr Osbeck (1723–1805), from Uppsala, who published his own diaries of the East Indies voyages in 1757 (Lindroth 1957, Blunt 1971). Specimens were preserved dried or in alcohol.

Odhelius's (1759) early student effort was published by Linnaeus in a compilation of "dissertations," the *Amoenitates Academicae,* his "Academic Favorites." Odhelius's descriptions reflected the variety of the collections: a scaly anteater (mammal), several birds and fishes, "insects" including crabs and isopods, and, gathered as Vermes, leeches, polychaetes, medusae, echinoderms, mollusks, true sea pens, and Linnaeus's *Pennatula sagitta,* now *Pennella sagitta.* This appears to be the first record of a copepod from Asia. The figure was of the broken termi-

Joh: L: Odhelius.

(left) ***Johan Lorens Odhelius (1737–1816). From Lindroth (1967b); signature from Lennmalm (1908).***

(right) ***Swedish naval base at Karlskrona in the time of Odhelius. From Lindroth (1967b).***

nal section only, hardly recognizable even today as a copepod. This specimen came from a *Lophius* (anglerfish) species, but the locality was not given.

Agassiz (1854) listed two other Odhelius papers to 1789; both were in Swedish journals and involved parasites. Hagen (1863) recorded one insect paper.

Odhelius was born in Strangnas, Sweden (about fifty km west of Stockholm) (Burius 1994). His father was a shopkeeper and member of the municipal court. Odhelius was a student at the Strangnas gymnasium from 1746 to 1748. He enrolled at Uppsala University in the spring of 1753 to study under Linnaeus and received his medical license in 1757. He was a medical practitioner at St. Mary's preschool in Stockholm in early 1758. By midyear, Odhelius was an army medical corpsman on the battlefields of Pomerania.[1]

Odhelius remained in Pomerania, sometimes as a hospital physician at Greifswald, for nearly two years. In the spring of 1760, he was assigned special medical duties at the navy's base in Karlskrona (southern Sweden). In his absence, he was awarded the M.D. from Uppsala University in June. A year later, he was a court physician, public health officer, and a teacher at the medical college in Stockholm. By 1763, he was senior physician at the general hospital in Stockholm, a position he held until 1813.

In 1775, Odhelius was selected by the admiralty to make improvements in medical procedures at the Karlskrona hospital and sanitarium. Also in this year, he was elected to the Swedish Academy of Sciences, of which he was president in 1776 and 1784. After 1813, Odhelius was medical councillor in the medical school.

In his methods of medical practice and scholarship, Odhelius was a typical representative of an eighteenth-century physician. His investigations were intimately dependent upon publication possibilities, and these generally required practical messages. From 1762, he published in the *Handlingar*[2] (Transactions) of the Academy of Sciences, usually short announcements and observations, in most cases from his experiences at the hospital. One paper was a detailed anatomy of intestinal worms. He also had a strong interest in pharmacology and published in this area.

Odhelius was one of the period's most outstanding Swedish physicians. He and some fellow academicians were among the early champions of Jenner's smallpox vaccine, which replaced the older inoculations around 1800. This procedure reached Sweden in the fall of 1801, and by 1804 there was a royal decree mandating vaccinations for everyone entering the kingdom. Odhelius tended toward specialization in eye diseases and related surgery, and his improvements in cataract operations and a treatise on eye diseases in 1807 brought him international recognition (Norrie 1891). His last important commission led to a manual on obstetrics published after his death.

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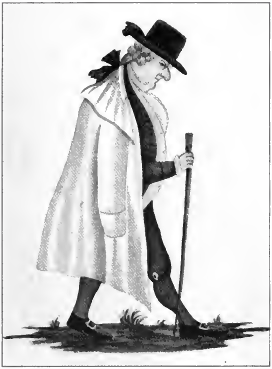
[1] Sweden lost most of its century-long cross-Baltic empire after the Great Northern War (1700–1721) but still struggled—until 1815—to retain what was left of West Pomerania, while Prussia, Saxony, Austria, and Russia disputed the adjacent territory in the Seven Years' War (1756–1763).

[2] The *Handlingar* was first published in 1739.



Johan Lorens Odhelius (1737–1816). From Lindroth (1967b).

Odhelius was an editor for the academy's Transactions and an acknowledged pioneer in the field of medical publications. He received the most popular medical writings and reviewed and condensed them for their educational value to the "under-informed." There had been a Swedish magazine *Lakeren och Naturforskaren* (Physicians and Naturalists) published sporadically in Stockholm from 1754 (Agassiz 1848); Odhelius was the editor from 1782 to 1807. The magazine provided Swedish physicians with the first information about foreign innovations.

Odhelius also had a strong interest for statistics and social medical analyses, and his periodic reports of mortality in Stockholm were widely utilized. In 1810, he was appointed to consider medical refinements for the entire country, using the statistics as a guide for better medical treatment and sanitary conditions. He was active in Stockholm's community life and lobbied for city-managed, tax-supported health services and hospitals. With respect to the present status of such programs in Scandinavian countries, it is interesting to note that the concepts, at least in regard to the medical aspect, seem to have originated in part with Odhelius.

Odhelius was active for the advancement of the status of physicians, and he proposed a society of physicians for Stockholm. Though not a founding member, he joined the Swedish Society of Physicians a year after it had begun in 1808, and he continued to have a prominent role in it (Lennmalm 1908). Odhelius belonged to a physicians' evaluation committee from 1810, and he advocated restrictions on priests in medical questions. He was relentless in his distrust in and pursuit of the then-popular quack doctors and alternative therapies (Burius 1994).

As if these efforts were not enough, Odhelius was uncommonly energetic with the management and finances of the Academy of Sciences. He held the post of honorary administrator continuously for thirty-five years. Not unexpected in a company of academically gifted men, few had the experience or the interest in mundane affairs. It was in these aspects, particularly, that Odhelius ran afoul of his fellows (Lindroth 1967b).

Yes, to this point it seems that Odhelius was too good to be true; however, I must interject that all came out well in the end. Everyone recognized Odhelius's steady character, attention to detail, and decisiveness. But over his long life, he was somewhat of a worry to the academy. Some of his colleagues found him to be a stubborn and aggressive perfectionist with the proper procedures always at his fingertips. Many surviving letters from the period mention that Herr Odhelius at the last meeting reminded everyone that "according to the rules it says. . . ." Even his best and oldest friends could not conceal their difficulties with the "choleric and inflexible medical councillor." Associates who would on one day refer to Odhelius's agreeable, captivating, and easy manner would on the next day point to his frightful violence and conflicts. One comrade at the medical college wrote that Odhelius was "spiteful and despotic, and that scarcely a session passed without a scene between Odhelius and one of his opponents." Another said "that troublesome person quarreled constantly, and is a demon in his college, and he has recently [1793] become the same in the Academy of Sciences." Once, after a meeting of the academy, Odhelius attacked a member and pulled him by the hair (Lindroth 1967b).

With years, it was agreed that Odhelius became milder, expressing more of his amiable and accommodating side. This was shown also in his love for poetry and the translation into Swedish of several English poems. He was often seen walking along the streets with a characteristic forward-leaning stride. When his life was over, Odhelius was given his due. An erstwhile critic wrote to Thunberg (Linnaeus's successor) in September 1816 that "old man Odhelius has died, and the academy has lost its true, and I have to say its only, pillar" (Lindroth 1967b). In spite of all the years of friction, no one doubted that Odhelius sought the academy's and the nation's own good, and that this public man, physician, and scientist would be missed.

Hans Strøm

25 January 1726–1 February 1797

Another Scandinavian, Hans Strøm, was a well-known Norwegian priest, educator, and general zoologist (Broch 1954). He was also a friend of O. F. Müller, providing Müller with collections for the "Fauna of Denmark" series. Several of Strøm's papers, from 1762 to 1784, make brief and repetitive mention of copepods (Agassiz 1854, Vervoort 1988). A large general work published in 1762, "A physical and economic description of the Søndmør District, situated in the Bergen Diocese in Norway," contained a few copepods as "insects" and "worms." Most of these were relegated to oblivion because of not using Linnaean terminology, or because of what may now be looked at as a comical error. One species, however, the parasitic females of which were described, remains a tribute to Strøm's early work: *Lernaea adunca*, now known as *Clavella adunca* (Strøm, 1762), the type species of the lernaeopodid siphonostome genus *Clavella*, established by Oken in 1816 (Kabata 1979).

Another parasitic species was the Tokne-Trold (throat-troll), *Lernaea corpore tereti flexuoso, tentaculis tribus subramosis*, which Linnaeus, in 1767, said was the same as his new *Lernaea branchialis*—now *Lernaeocera branchialis* (Linnaeus, 1767)—and which he placed in Vermes.

Strøm described a third species from Søndmør as a Torskeluus (codfish-louse). Baird (1850) noted that Strøm illustrated this head-downward, believing that the tail was the head and the two long egg-strings were antennae or "rowing hairs." Strøm's figures were reprinted by Berland and Margolis (1983). These are likely of the male and female of a *Caligus* species. Indeed, the founder of *Caligus*, and coworker with Strøm, said that *Caligus curtus* was identical to Strøm's Torskeluus (Müller 1785). Temporarily adding to the confusion, Müller (1776) at first listed this species as *Binoculus piscinus*.

Hans Strøm (1726–1797). From Broch (1954).

There is some question regarding the dates of two of Strøm's subsequent papers, both of which are short and deal only with copepods. The first, "A one-eyed sea-hopper with two long rowing-hairs," part of a series on Norwegian insects, appeared in the Copenhagen *Skrifter* (Proceedings), volume 9, and is dated by both Baird (1850) and Vervoort (1988) as 1765; this is likely correct. Unfortunately, these rare papers are not easily located for verification, and even when found, postpublication bindings may have misplaced title and date pages. The copepod mentioned is probably the female of the incorrectly oriented "codfish-louse" of 1762.

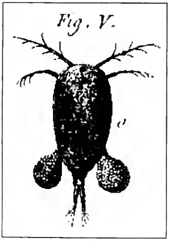
The second of these two papers, "On a salmon-louse with an oblong-round dorsal-shield and back-part," appeared in the Copenhagen *Skrifter*, volume 10, a few pages before Gunnerus's famous paper of 1770. This too was in Strøm's series on Norwegian insects. Both Strøm's and Gunnerus's papers have been cited as 1765; however, Gunnerus did not see the described *Calanus finmarchicus* until 1767, and the consulted title page of volume 10 convinced me that the publication date was 1770. Baird (1850) and Berland and Margolis (1983) gave the date of this Strøm paper as 1770, and I believe this to be correct. Baird (1850) thought that this copepod was the disoriented male "codfish-louse" (*Caligus* species) from

Etienne Louis Geoffroy (1725–1810). From the Academy of Sciences of France, courtesy of Jean Theodorides; photograph by Jean-Loup Charmet.

1762. Strøm apparently believed then that there were two species, one with and one without long "antennae" (actually egg strings). Strøm called this second "species" *Monoculus thorace abdomineque ovato, cauda lobata,* a name echoing the paper's long title. Not surprising, Müller (1785) eventually said that this "species," too, was the same as his *Caligus curtus,* but not before holding it for a few years under the ever-confusing name of *Binoculus piscinus* (see Müller 1776). Berland and Margolis (1983), who also reprinted Strøm's figures from 1770, stated that the species is *Lepeophtheirus salmonis* (Krøyer, 1837).

Vervoort (1988) listed two final Strøm papers, both from 1784: "Remarks on the Søndmør description" and "About herring-(food) or red-food." These papers appeared in the first volume of the new series of Norwegian *Skrifter,* although still published in Copenhagen. Müller (1785) cites the first one as repeating Strøm's long-named monoculus.

Strøm was born at Borgund in Søndmør (Hagen 1863). He had been a student at the University of Göttingen, Germany. His professor was Johann David Michaelis (1717–1791), theologian and orientalist. It was Michaelis who first suggested the Danish expedition to "Arabia Felix." Strøm was one of two pupils recommended by Michaelis to participate. It was fortunate for Strøm that he did not go, but the alternative was disastrously unsuited, leading to fatal dissension within the expedition's ranks (Wolff 1968).



"Le monocle a queue fourchue," **Monoculus quadricornis** *Linnaeus (Geoffroy 1799).*

Etienne Louis Geoffroy

2 October 1725–12 April 1810

Etienne Louis Geoffroy's father was the widely traveled Etienne François Geoffroy (1672–1731), a well-known physician and chemist, whose own father was a founder of the Royal Academy of Sciences in 1666 (Cap 1854, Lamy 1929). Etienne Louis was born in Paris and did his early studying at Beauvais. He studied medicine at Paris and revealed strong interests in botany and chemistry, earning his preliminary degree ("licence") in 1746 and his M.D. in 1748 (Jourdan 1821a). He was a practicing physician who also conducted noteworthy zoological research. He refused an appointment as Professor of Medicine at the College of France, apparently because it would have impacted his zoology.

Etienne Louis Geoffroy published a two-volume work in Paris in 1762 and 1764, *Histoire abregée des insectes qui se trouvent aux environs de Paris, dans laquelle ces animaux sont rangés suivant un ordre méthodique.* Geoffroy arranged "des insectes" mostly as Linnaeus, with many details added to beetles (Fabricius 1778). Copepods and copepod relatives were apparently described in the 1762 volume, within the Aptera. Geoffroy had no difficulty seeing that some otherwise monoculi had two eyes; it was natural for him to assign these to a new genus, *Binoculus.* Geoffroy asserted that all monoculi are oviparous and live only on vegetable matter. Species in his new genus were parasitic on fish. One of these was *Binoculus gasterosteus,* a synonym of *Argulus foliaceous* (see Wilson 1902). Another species was *Binoculus haemisphaericus,* which Baird (1850) said "bears some resemblance to a Caligus." In spite of its two eyes, Linnaeus in 1767 said that *B. haemisphaericus* was the same as his *Monoculus piscinus.* Linnaeus could claim priority here since *M. piscinus* had been mentioned in his "Fauna of Sweden" in 1746. However, this pre-Linnaean Linnaean name has no nomenclatural status. We will soon see that the opinions of others placed Linnaeus's *M. piscinus* into the caligids, supporting both Linnaeus's and Baird's contentions.

Geoffroy (1799), in "Year VII of the Republic," brought out a "new Edition, revised, corrected, and augmented with a considerable Supplement." It was this version that I was able to consult. There was no indication that the copepod parts were revised. The figure of *Binoculus haemisphaericus* was very poor. From the description, I am inclined to equate it with argulids rather than caligids.

Geoffroy's (1799) figure of "the monoculus of four horns" was, as Jurine (1820) observed, "worthless." Of specific characteristics there are none; one can only note the "four horns" (from the first and second antennae), the two egg sacs, and the caudal rami, making it at least an unmistakable copepod.

Geoffroy described four other monoculus species, now seen to be two cladocerans and two ostracods.

Geoffroy published another treatise, on land and river shells (mollusks), in 1767 (Agassiz 1853). In 1780, he made a comparative study of the ear in fish, amphibians, and man. He also wrote several medical texts (Jourdan 1821a). After a long and honorable career in Paris, he was devastated by the torment and terror of the Revolution, and he retired to Chery-Chartreuve, near Soissons (Aisne). He eventually became mayor of that village and served in the department's medical administration. He died at Chartreuve in 1810 (Guyot de Fere 1857, Lamy 1929, Tetry 1982).

In 1798, Geoffroy was elected a nonresident (i.e., not in Paris) associate of the National Institute (anatomy and zoology section). Carus (1872), Miall (1912), and Lamy (1929) noted that Geoffroy was the nephew of the botanist/conchologist Claude Joseph Geoffroy (1685–1752), brother of Etienne François Geoffroy. One of Etienne Louis's sons, René Claude Geoffroy (1767–1831), was also a physician/naturalist and a member of the Academy of Medicine.

Johan Anton Scopoli

13 June 1723–8 May 1788

Johan Anton (or Giovanni Antonio) Scopoli was called by J. C. Fabricius (1805), soon to be introduced, "one of the greatest entomologists." In 1763, Scopoli published his *Entomologia Carniolica,* in Vienna (Tuxen 1973). Baird (1850) said that this work illustrated *Monoculus quadricornis,* which we believe now to be a composite species of many freshwater *Cyclops* species. The copy of Scopoli (1763) that I examined was missing the last half of the plates, so I was unable to observe the figure. Scopoli appears to have included a figure for each of his numbered species; note that "1139," the copepod, was misprinted as "1129."

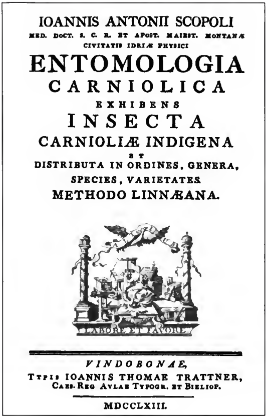
Scopoli found *Monoculus quadricornis* in lakes and usually abundant. He referenced his species to those described by Linnaeus and Roesel. He placed the copepod in his seventh and last insect order, Pedestria, apparently equivalent to Linnaeus's Aptera. Scopoli's Pedestria included a mixed bag of insects, mites, scorpions, spiders, and crustaceans.

Johan Anton Scopoli (1723–1788). From Stafleu (1971), courtesy of the International Association for Plant Taxonomy.

Although Scopoli did not report the length of his copepod, the lengths of most other specimens were given in lines. Rather than leaving the reader of two centuries later to puzzle over the dimensions of some obscure Austro-Hungarian unit, Scopoli conveniently provided a scale for *Tres unciae parisinae* (Three Parisian inches), with one subdivided into twelve lines. These inches measured about 26.5 mm, so that Scopoli's French line would be about 2.2 mm (compared to an English line of approximately 2.1 mm). We will see that this is essentially the same unit used by Jurine in 1820.

Carniola, sometimes called the Krain, is the mountainous region north of the Adriatic Sea. In Scopoli's time, it was controlled by the Austro-Hungarian Empire. Scopoli also published a flora of the region in 1760 and 1772. He was said to be a friend of Linnaeus, who named after him the herb *Scopolia,* from the roots of which is derived the alkaloid scopolamine (*Webster's* 1960). Scopoli promoted the introduction of Linnaean principles into south central Europe (Stafleu 1971). Nearly one thousand plants, including cryptogams, were described by Scopoli.

While Linnaeus had used wings and Fabricius mouthparts as the single characters for their insect classifications, Scopoli stressed that natural classifications were not based on either alone, but on care-



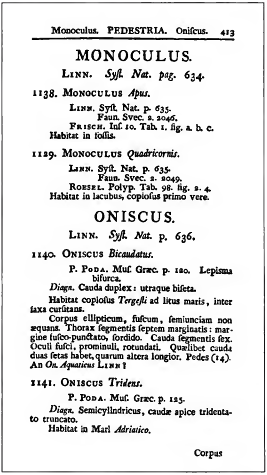
IOANNIS ANTONII SCOPOLI
MED. DOCT. S. C. R. ET APOST. MAIEST. MONTANÆ
CIVITATIS IDRIÆ PHYSICI
ENTOMOLOGIA
CARNIOLICA
EXHIBENS
INSECTA
CARNIOLIÆ INDIGENA
ET
DISTRIBUTA IN ORDINES, GENERA,
SPECIES, VARIETATES.
METHODO LINNÆANA.

LABORE ET FAVORE

VINDOBONAE,
TYPIS IOANNIS THOMAE TRATTNER,
CAES. REG AULAE TYPOGR. ET BIBLIOP.

MDCCLXIII.

(left) *Title page of Scopoli's* Entomologia Carniolica *(1763).*



Monoculus. PEDESTRIA. Oniſcus. 413

MONOCULUS.

LINN. *Syſt. Nat. pag.* 634.

1138. MONOCULUS *Apus.*

LINN. Syſt. Nat. p. 635.
Faun. Svec. 2. 2046.
FRISCH. Inſ. 10. Tab. 1. fig. a. b. c.
Habitat in foſſis.

1129. MONOCULUS *Quadricornis.*

LINN. Syſt. Nat. p. 635.
Faun. Svec. 2. 2049.
ROESEL. Polyp. Tab. 98. fig. 2. 4.
Habitat in lacubus, copioſus primo vere.

ONISCUS.

LINN. *Syſt. Nat.* p. 636.

1140. ONISCUS *Bicaudatus.*

P. PODA. Muſ. Græc. p. 120. Lepisma bifurca.

Diagn. Cauda duplex: utraque biſeta.

Habitat copioſus *Tergeſti* ad litus maris, inter ſaxa curſitans.

Corpus ellipticum, fuſcum, ſemiunciam non æquans. Thorax ſegmentis ſeptem marginatis: margine fuſco-punctato, ſordido. Cauda ſegmentis ſex. Oculi fuſci, prominuli, rotundati. Quælibet cauda duas ſetas habet, quarum altera longior. Pedes (14). An *On. Aquaticus* LINN?

1141. ONISCUS *Tridens.*

P. PODA. Muſ. Græc. p. 125.

Diagn. Semicylindricus, caudæ apice tridentato truncato.
Habitat in Mari *Adriatico.*

Corpus

(right) *Record of* Monoculus quadricornis *Linnaeus from Scopoli's* Entomologia Carniolica *(1763).*

ful observations of the entire animal structure. In this way, he anticipated Latreille (Lindroth 1973). Hagen (1863) listed seven other insect papers besides the *Entomologia Carniolica.*

Scopoli was born in Cavalese, a small town in the Trentino region of northeast Italy; his father was a doctor of law (Guglia 1972, Violani and Giordano 1988). The political history of this region has always been dynamic, complex, and confused. Nominally a part of the aging Republic of Venice, the administration seems to have been mainly through the Austro-Hungarian Empire. From youth, Scopoli had a strong interest in botany. With the help of a local apothecary, he began a plant collection while at the gymnasium in Cavalese. Scopoli's earliest studies beyond his home were at Trento, to the south, and at Hall, near Innsbruck, in the Austrian Tirol.

In 1743, Scopoli received an honors degree in medicine at the University of Innsbruck. He then practiced the profession in his homeland and in Venice. Botanical studies then held him for two years, while he studied in Austria, at Graz and at nearby Seckau, attracting the attention of the secretary to the archbishop.

In 1753, Scopoli obtained a degree of Professor of Medical Practice for Imperial Austria with a thesis on systematic botany, subsequently published in Vienna. In the next year, one of the reorganizers of the Faculty of Medicine in Vienna invited Scopoli to Idria (now in Slovenia, near Ljubljana), as physician to the laboratories of the famous mercury mines (discovered in 1490). Scopoli said he dedicated altogether sixteen years to medical practice, ten of which were in Idria. In these years he also managed to conduct his best botanical and zoological work. Unfortunately, it was also a period of extreme economic hardship, worsened by the deaths of his wife and two children when their home caught fire.

An opportunity to commit even more time to science came in 1763 with a much-appreciated appointment to the Chair of Mineralogy and Chemistry at a new school of mining in Idria. Scopoli was soon given an even more prestigious professorship, in 1769, that of Chemistry and Botany at the Academy of Mining in Schemnitz, in Hungary (now Banska Stiavnica, an old silver- and gold-mining town in the southeastern Czech Republic, about 180 km east of Vienna). Contributions from that period are his "Dissertations on Pertinent Natural Sciences" and "Principles of Mineralogy" (both from 1772); "Crystallography of Hungary" (from 1776); and "Introduction to Natural History" (from 1777), a five hundred-page general text dedicated to Empress Maria Theresa of Austria (Agassiz 1854, Guglia 1972).

Scopoli lost his second wife in Schemnitz and married a third from a leading local family. From this union came the only child to outlive Scopoli, Johann (1774–1854), who became a respected statistician.

Scopoli's unrealized ambition was to be the first Professor of Natural History at the University of Vienna. Instead, his last position, in 1776, was as Professor of Chemistry and Botany at the University of Pavia (supposedly founded by Charlemagne in 774), in Lombardy. This return to his homeland was marked by several notable achievements. Scopoli developed the still-famous botanical gardens and established the chemical cabinet in the natural history museum. His most important publication from this period was the three-volume "Favorite Flora and Fauna of Insubria" (the Milan region) from 1786 to 1788.

Johan Anton Scopoli (1723–1788). From Bonnet (1945); signature from Stafleu (1971).

Swainson had some interesting things to say about Scopoli:

> He writes in the spirit of the *Systema Naturae,* and the excellence of his descriptions shows he was an accurate observer and a really good naturalist. . . . With that moral courage which bespeaks an honest and a good heart, he had the "temerity" to expose the disgraceful thefts made by Spallanzani of objects from the public museum. The interest of the accused, however, supported him; and although the proofs adduced were unanswerable, the remainder of Scopoli's life was rendered miserable by the persecution of Spallanzani's friends. (Swainson 1834)

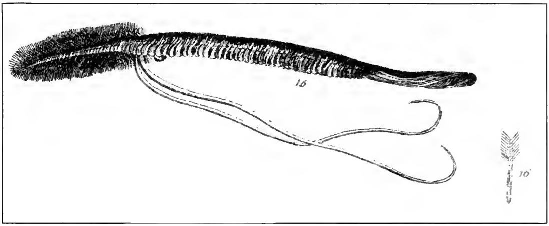
Lazzaro Spallanzani (1729–1799) is better remembered for his important experiments in the decline and fall of spontaneous generation.

The notorious polemics from this last sad episode embittered Scopoli, and he died in Pavia, sick and nearly blind. Scopoli was remembered by a large number of students, colleagues, and correspondents as an honorable man and a zealous scholar. He is esteemed by both Austria and Italy as a cosmopolitan spirit having a significant role in the blossoming of European science in the eighteenth century (Guglia 1972, Violani and Giordano 1988).

Bonnet (1945) believed that Scopoli was the first to use the names of naturalists for species names, although this would follow inherently when referring to species described earlier by others.

Pavia li 17. Feb.° 1786

Divotiss.mo ed umilis.mo Serv.e
Giò. Ant.o Scopoli



Two species of copepods considered as sea pens by Ellis (1764). Ellis called the first (Fig. 15)* Pennatula filosa, *after Linnaeus, and copied Boccone's (1671) figure. He recorded the second (Fig. 16) as* P. sagitta, *but drew only the terminal section.

Scopoli's summary:

> Never forget, dear reader, that I do not study the Natural Theater with regard to a profession, but from an absorbing preference, to soften the melancholy of a far too sad life. (Scopoli's 1789, *Deliciae Florae et Faunae Insubricae*. . . ., qtd. in Guglia 1972)

John Ellis

? 1705?–18 October 1776

John Ellis was likely a native of Ireland, although his place of birth is unknown (Savage 1934). He was an influential merchant in London (Rauschenberg 1978). As a strong friend of Sloane's personal museum, Ellis helped host Linnaeus in London in 1736 (Dobell 1958, Gunthet 1980). He was admitted as a Fellow of the Royal Society in 1754. Although he was not the first to say so, Ellis was essentially the first to convince most zoologists that sponges and corals were animals, refuting Job Baster and others:

> So . . . I must conclude, that though they grow in a branched form, they are no more allied to vegetables than they are to the ramified configurations of [salt crystals]. . . . Hence it appears, that this metamorphosis of a plant to an animal is a flowery expression, . . . better suited to the poetical fancy of an *Ovid,* than to that precise method of describing which we so much admire in a natural historian. (Ellis, 1775, qtd. in Rauschenberg 1978)

In 1768, the Royal Society awarded its Copley Medal to Ellis, "as the most public mark that the Council can give of their high sense of the great accession which natural knowledge has received from your most ingenious and accurate investigations" (Johnston 1847).

> [Peter] Collinson and [John] Ellis were never in America, yet if any men deserve to be called the fathers of American natural history it is they. For a period of thirty years or more, that period during which Linnaeus was bringing about those reforms which have associated his name forever with the history of the classificatory sciences, these enlightened and science-loving London merchants seem to have held the welfare of American science in their keeping and to have faithfully performed their trust. I know few books which are more delightful than Darlington's Memorial or Bartram and Smith's Correspondence of Linnaeus, made up as they are largely of the letters which passed between Collinson [a botanist] and Ellis and their correspondents in America, and with Linnaeus, to whom they were constantly transmitting American notes and specimens. . . . Ellis was a more eminent man of science, and his name is associated with the beginnings of modern marine zoology. . . . He was royal agent for West Florida, and had extraordinary facilities for obtaining specimens from the colonies. Linnaeus wrote to him in 1769 that he had "laid open hitherto unknown Indies in the depths of the ocean." (Goode 1901a)

In 1754, Ellis explored the coast of Kent and Sussex with G. C. Oeder, a Danish botanist who will be mentioned shortly in conjunction with O. F. Müller's life.

Ellis (1764) published a general account of sea pens which, except for two species of copepods, were zoophytes (coelenterates). Ellis referred to both *Pennatula filosa* and *P. sagitta*. The first was Boccone's species, with Linnaeus's name; Ellis copied Boccone's figure. The second copepod was attributed to Linnaeus's species, "said to infest the Lophius Histrio or sea-bat, in the Chinese Sea." Ellis's figure showed only the pitiful broken terminal section.

Agassiz (1850) listed twenty other Ellis papers on zoophytes. Ellis also published papers on tropical plants, particularly Venus' flytrap, breadfruit, and coffee, and on methods for safeguarding seeds and plants during long voyages.

Ellis knew or corresponded with more than a hundred persons likewise interested in natural history, including the American botanist Alexander Garden, F.R.S. (1728–1792), for whom Ellis named the immortal *Gardenia.* Ellis's friendship with Linnaeus never flagged, and Linnaeus was lavish in his praise for Ellis:

> You in these minute and almost invisible beings, have acquired a more lasting name than any heroes and kings by their cruel murders and bloody battles. I congratulate you on this, your own stupendous victory, over the barbarous ignorance which hitherto has held the philosophic world in subjection. (Linnaeus, 1758, qtd. in Rauschenberg 1978)
>
> You are still the main support of Natural History in England, for your attention is ever given to all that serves to increase or promote this study. Without your aid, the rest of the world would know little of the acquisitions made by your intelligent countrymen, in all parts of the world. You are the portal through which the lovers of Nature are conducted to these discoveries. For my own part, I acknowledge myself to have derived more information, through your various assistance, than from any other person. (Linnaeus, 1772, qtd. in Rauschenberg 1978)

There is no known portrait of Ellis. He was said by James Edward Smith to be tall, with expressive, strongly marked features. A niece of a close friend had a 1769 diary entry: "He is a very humorous comical old gentleman" (Savage 1934). The Ellis natural history collection was sold on 10 June 1791, from a printed list of twelve pages.[3]

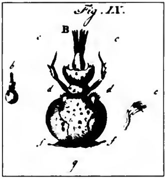
Job Baster

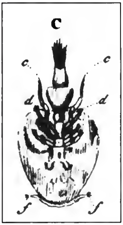
2 April 1711–6 March 1775

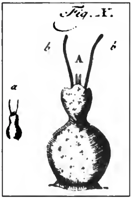
In Holland, Job Baster published a general work in both Dutch and Latin, usually referred to by the shortened Latin title *Opuscula Subseciva* (Tuxen 1973); the longer translated title adds "A minor work on remaining observations concerning miscellaneous marine animals and plants which spawn and produce in moderation." There were two volumes, one each in 1759 and 1765, published at Haarlem. Johnston (1847) refers to Baster as "the Dutch naturalist," from Zurichsee in Zealand, and had several unflattering things to say about him.

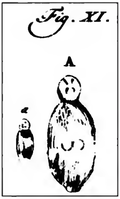
In his second volume, Baster (1765a,b) described two species of caligid copepods. Not for the first time were these strange parasites interpreted upside-down (Baird 1850). The first species listed was "a fish-louse from a halibut (*Pleuronectes*)," with a fair illustration showing some details both dorsal and ventral. The second species was "a fish-louse from a codfish," with a drawing of lesser quality. These two species were placed by Müller (1785) in his new genus *Caligus* and are discussed at that point.

A third species of fish-louse was believed by Baster to be a *Lernaea,* but the ghastly figure looks like a cross between that and an argulid. Baird (1850) thought it was an argulid, undoubtedly based more on the text than the drawing. Baster equated his species to Gissler's from 1751.

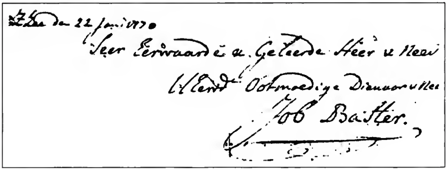








"Fish louse from a halibut" (Fig. IX; B, C), "fish louse from a codfish" (Fig. X), and Lernaea *sp. (Fig. XI). From Baster (1765a,b); signature from van Benthem Jutting (1970).*



Z.Zee de 22 Jan. 1770

Zeer Eerwaarde en Geleerde Heer en Neev

UEdts. Ootmoedige Dienaar en Neev

Job Baster.

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3. Listed in the British Museum Library catalog.

Baster declares himself in his books to be a Doctor of Medicine and a member of the Royal Societies of London and Holland. Agassiz (1848) has seven publications by Baster on zoophytes and marine organisms.

DUTCH FISHING BOATS

Baster was a Boerhaave student at the University of Leiden, forming a personal friendship with this father-figure professor (Nagtglas 1875, van Benthem Jutting and van Hoorn 1967). When Baster died in 1775, Slabber recalled him as "my recently departed friend, the learned Heer Job Baster" (van Benthem Jutting 1970). Baster is well remembered in Holland for the variety and originality of his inquiries. The journal of the Netherlands Malacological Society was begun as *Basteria* in 1936 (Henrard and Koumans 1936). I am pleased to have noticed at least one mollusk-related copepod paper in this periodical (Stock 1952).

Houttuyn's (1769) water flea Monoculus piscinus *Linnaeus, 1767 (Figs. 2–3). Courtesy of the Nationaal Natuurhistorisch Museum, Leiden.*

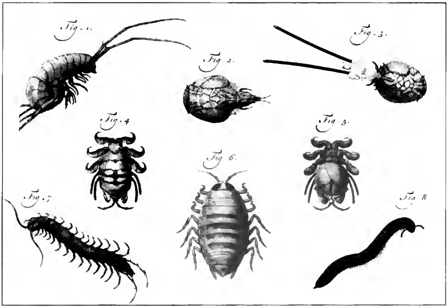


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4
Fig. 5.
Fig 6.
Fig. 7
Fig 8

Linnaeus Revisited

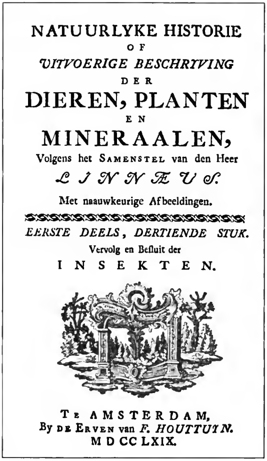
Two final Linnaean species are introduced here, instead of in the Linnaeus chapter, to keep the soon-to-be complex narrative in chronological order. Linnaeus's last opportunity to revise his ever-expanding *Systema Naturae* was in 1766–1768, with the twelfth edition now in three volumes. In the second of two volumes on animals, Linnaeus introduced *Lernaea branchialis,* another of the wormlike parasites we now know to be copepods. This species has stood the test of time, but like most "lernaeids" it is no longer in that venerable genus. Now it is *Lernaeocera branchialis* (Linnaeus, 1767), the type species of the siphonostome genus *Lernaeocera,* introduced by de Blainville in 1822 (Wilson 1917a, Kabata 1979). This is straightforward.

The second copepod species from Linnaeus's twelfth edition has not been treated so kindly by posterity. This was the result of its being so briefly described, and by its immediate association with a number of unrelated species. Recall Linnaeus's *Monoculus foliaceous* from the tenth edition of 1758. This has become the type species of *Argulus foliaceous* (Linnaeus, 1758) (see Wilson 1902), now not even considered a copepod. In the twelfth edition, Linnaeus added *Monoculus piscinus.* Both of these species were later placed in Geoffroy's *Binoculus,* for the good reason that they have two eyes. Poor *Binoculus* as a genus did not fare well, because so many apterous insects had two eyes, and the group soon held a large number of unrelated forms. The two just-mentioned monoculi are good examples. Some authorities listed *M. piscinus* as a synonym of *M. foliaceous* (e.g., Wilson 1902). However, I believe, as have others much closer to the scene of birth, that *M. piscinus* is the parasitic copepod described by Müller (1785) as *Caligus curtus,* which remains as the type species of the genus (Fabricius 1780, Müller 1785, Baird 1850).

Martinus Houttuyn

? 1720–27 April 1798

Martinus Houttuyn was more than an early ichthyologist, the main field in which he is remembered; his explorations into all areas of natural history also included some words on copepods (Vervoort 1986b). His first work to mention copepods was a Dutch translation of Henry Baker's *Employment for the Microscope,* from 1756. According to W. Vervoort (pers. comm., 25 March 1997), this was not merely a translation; it contained a number of Houttuyn's original observations.



NATUURLYKE HISTORIE
OF
UITVOERIGE BESCHRYVING
DER
DIEREN, PLANTEN
EN
MINERAALEN,
Volgens het SAMENSTEL van den Heer
LINNÆUS.
Met naauwkeurige Afbeeldingen.
EERSTE DEELS, DERTIENDE STUK.
Vervolg en Beſluit der
INSEKTEN.

TE AMSTERDAM,
By DE ERVEN van *F. HOUTTUYN.*
MDCCLXIX.

(left) ***Title page of Houttuyn's "Natural History and Detailed Description of Animals, Plants, and Minerals" (1769). Courtesy of the Nationaal Natuurhistorisch Museum, Leiden.***

Houttuyn's greater impact in our area came between 1761 and 1785 with the publication of a monumental thirty-seven-volume "Natural History and Detailed Description of Animals, Plants, and Minerals," based on Linnaeus. About half of the work was zoology and included invertebrates up to and including the insects. Houttuyn's *Natuurlyke Historie* dealt with the birds through beautiful colored plates. As before, this was not merely a repetition of Linnaeus, but contained numerous novel remarks in a much larger publication than Linnaeus's zoology.

Within this series, Houttuyn (1769) included several types of "water flea," two of which were copepods. The first was the "water flea with a heart-shaped flat shield," which Houttuyn referred to as *Monoculus piscinus* Linnaeus, described only two years before. This is definitely a caligid, as represented by two good figures. Houttuyn also compared his form, "a type found in both freshwater brooks and the sea," with Baster's fish-lice. He recalled that Baster had placed these near the crawfish crustaceans. Houttuyn also thought these to be similar to De Geer's two-eyed *Binoculus.* The other water-flea copepod was Linnaeus's *Monoculus quadricornis,* mentioned (but not figured) by way of several previous records.

HENRY LOUIS DUHAMEL
Chevalier S.r du Monceau et de Vrigny
de l'Academie Royale des Sciences &c

(right) ***Henri Louis Duhamel du Monceau (1700–1782). From de Beer (1948).***

Houttuyn was born in Hoorn, the larger of two Dutch towns of the same name, this being on the shore of the Zuiderzee. His father was a physician who sent young Houttuyn to the University of Leiden for a medical doctorate, which he obtained in 1749. He returned to his birthplace as a surgeon, remaining there only until 1753 when he moved permanently to Amsterdam. Unfortunately, there is no known portrait of Houttuyn (Boeseman 1995).

In 1782, Houttuyn published a paper on Japanese fishes, including descriptions of a few other marine organisms (Boeseman 1995). He also coauthored the series (with Nozeman) on the "Natural History of the Birds of the Netherlands." He was a member of the Zeeuwsch Society for Art and Science and of the Netherlands Academy of Sciences.

Henri Louis Duhamel du Monceau

? 1700–13 August 1782

Desmarest (1825) referred to an obscure work by Henri Louis Duhamel du Monceau, from 1769: "Observations sur les insects qui s'attachent aux poissons, et description d'un insecte qui s'attache aux saumons," *Arts et Metiers, peches* 2(2):293–?. Desmarest says this is *Caligus,* but the record seems not to have gotten into the mainstream copepod literature. Agassiz (1850) has for 1769 a three-volume work on fishes, and the reference is likely from that.

Most of what I have learned about Duhamel du Monceau was written by Vicq-d'Azyr (1785). Duhamel was well known outside of copepodology as a chemist and as an early promoter of the antiscorbutic properties of fresh vegetables (Grmek 1968). He was born in Paris into a Dutch family that had come to France in 1400. Duhamel's early schooling was a boring disaster for him until he discovered physics. He then attended classes at the Jardin du Roi, under one of the famous Geoffroys, the de Jussieu brothers, and Buffon's predecessor Charles François de Cisternay Dufay (1698–1739), enjoying their lectures so much that he took an adjacent residence.

Duhamel's first research, suggested by Antoine de Jussieu (1686–1758), was on the pathology of the saffron plant and of damage to other crops by parasitic insects. He decried the devastation of forests for firewood; he would have been struck dead if he could have seen what we have done now to our forests everywhere.

Through correspondence and acquisition of specimens from French botanists in North America, Duhamel became a master of Canadian flora (Leroy 1957). In seeking environmental information, he encouraged the first meteorological records from "New France" (Quebec). From this interest he coauthored a book in 1752 on techniques for transporting living plants and animals from the New World to the Old. (Following these instructions, La Pérouse delivered grains and fruit trees to the Franciscans at the Carmel Mission, California, in 1786.) In 1755, Duhamel published a treatise on cultivated trees, especially those from North America, in France.

Five years earlier, in 1750, Duhamel published the first French manual for the health of seamen. He encouraged ventilation below decks, as well as a proper diet, including fresh fruits and vegetables. Concurrent with this interest, he became the inspector of the navy for the Royal Academy of Sciences. Whenever he was able, he enjoyed the company of fishermen. His last work was the three-volume treatise on fish and fishing.

Duhamel was appreciated in and beyond his own country. Thomas Pennant met him in Paris in 1765 and examined his cabinet, "rich in sea urchins and corals" (de Beer 1948). Duhamel was elected a Fellow of the Royal Societies of London and Edinburgh, and a member of academies in St. Petersburg, Stockholm, Palermo, Leiden, and others. He was stricken with his last illness while at a meeting of the Academy of Sciences.

Antoine Joseph Pernetty

13 February 1716–? 1801

Zoologists, formally trained or otherwise, were adding records of copepods found by themselves in distant waters. One of these reports came from Antoine Joseph Pernetty, an eminent naturalist and keen observer. Pernetty was born in Roanne in central France. He became a priest in the Benedictine order, acquiring the title of "Dom.," for *Dominus* (Master). He was employed in the Abbey St. Germaine-des-Prés for literary work and translating. Pernetty published several books at this time, the best known being those on Egyptian and Greek fables, a discourse on physiognomy, and a dictionary of mythology (Anon. 1867).

Pernetty was invited by King Louis XV to be chaplain on Bougainville's colonizing expedition to the Falkland Islands (the Isles Malouines) in 1763–1764 (Thiery 1932, Pilleri and Arvy 1981). In 1770, Pernetty published an account of this voyage, with a classic description and illustration of a porpoise. He included a figure of the same parasitic copepod species described by his classical predecessors, which he found on an Atlantic tuna.

In 1765, Pernetty asked to be removed from the Benedictine rule and soon after appeared in Berlin, employed by Frederick II, King of Prussia, as administrator for the Berlin Library. The Benedictines, in the meantime, made Pernetty an abbot *in partibus,* so he was able to remain in Berlin (Anon. 1867). Pernetty was admitted as a member of the Prussian Academy of Sciences. He came back to Paris in 1783 but was obliged to leave during the troubles of the Revolution. His last years were taken up by metaphysical studies of witchcraft, ghosts, and the philosopher's stone. Pernetty died in Venice in 1801.

Johan Ernst Gunnerus

26 February 1718–25 September 1773

An important name in copepods at this time was Johan Ernst Gunnerus, sometimes in the non-Latin form Gunner. Gunnerus was the first Norwegian zoologist to adopt Linnaeus's system. Although not strictly a Linnaean student, Gunnerus was in direct contact with Linnaeus through their many letters, and he studied Linnaeus's work thoroughly (Broch 1954). Apparently Linnaeus and Gunnerus never met face to face, although they remained close by way of several mutual students and mutual respect (Nordhagen 1950). Gunnerus had a strong botanical interest and published the first distinctly Norwegian flora from 1766 to 1776. Linnaeus named a plant genus, *Gunnera,* after Gunnerus.

Gunnerus was born in Christiania (later Oslo), where his father was a city physician with strong research interests in anatomy, perhaps imparting to his son a predisposition for biology. However, Gunnerus attended the Cathedral School from 1729 until 1737, grounding himself in theology and philosophy. After a few years in Copenhagen, Gunnerus attended the universities at Halle and then at Jena (both in Germany) in 1742–1754, where he developed an interest in natural history. He was appointed Professor of Theology at the University of Copenhagen in 1755 (Broch 1954, Sivertsen 1961), the same year Pontoppidan became vice-chancellor.

In 1758, King Frederik V named Gunnerus the Bishop of Trondheim, on Norway's west central coast. Trondheim had always been one of Norway's largest and most important towns and was the capital until 1380. Norway's finest cathedral, where all the kings are crowned, is in Trondheim.

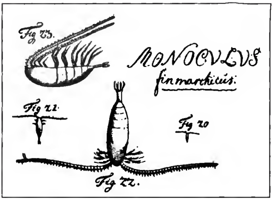


Fig 23.
Monoculus
finmarchicus.
Fig 21.
Fig 20
Fig 22.

The first published illustration of a free-living marine copepod, now well known as* Calanus finmarchicus. *From Gunnerus (1770).

From this time onward, Gunnerus always found time for scientific affairs. The first year in Trondheim saw him dedicated to the establishment of a literary and scientific society. Aided by Gunnerus's international reputation, The Trondheim Society became a reality by 1760; a publication series, the *Skrifter,* ran from 1761 to 1765, the oldest scientific journal in Norway. Gunnerus authored articles in the Trondheim *Skrifter* from its first year, with his first zoological work being about seabirds. Subsequent articles dealt especially with fish, but because of their obscurity, these were not well known (Krøyer 1850). By 1767, Gunnerus's gather-

(left) ***Johan Ernst Gunnerus (1718–1773). From Broch (1954).***

(right) ***Johan Ernst Gunnerus (1718–1773), offering "Hope, not Confusion." From Nordhagen (1950).***

ing became "The Royal Norwegian Scientific Society in Trondheim," continuing the *Skrifter* as the first royal Norwegian science publication; the *Skrifter* was published from 1768 to 1774 (Agassiz 1848, Broch 1954).

From Trondheim in 1759, Gunnerus made the first of several trips through the north country to Finmark, where he became committed to studies in botany and zoology, even more than to his theological thoughts (Broch 1954). (More likely, he combined them.) Of greatest interest to him were marine animals. In June 1767, on a visit to Hammerfest, Europe's northernmost city, Gunnerus was the recipient of a remarkable and historical gift.

This gift, of course, was the bottle of live *Calanus finmarchicus* brought to Gunnerus by a Hammerfest merchant. Gunnerus (1770) subsequently published the first account of a free-living marine copepod, placed in the Linnaean genus *Monoculus,* new species *finmarchicus.* The title of Gunnerus's paper, his best known, translates to "Some small, fine, and mostly new Norwegian sea-animals," printed in the *Skrifter* of the Copenhagen Society of Scholars and Lovers of Science. The article described seven marine animals: four in Linnaeus's Mollusca (sea-slugs), two in Intestina (nemertines), and one, the *Monoculus finmarchicus,* in Insecta (copepod).

Even though this was a moderately obscure publication, it seems to have reached the right places, for it was readily incorporated into the growing body of copepod literature. Unfortunately, as will soon be shown, there was an initial misidentification that caused nearly one hundred years to pass before *Monoculus finmarchicus* settled down to the correct *Calanus* species. Giesbrecht (1892) translated into German Gunnerus's description and reprinted the rearranged figures. Gunnerus had the two larger figures on the back and head-down, respectively. Marshall and Orr (1955) translated the description into English and repeated the four figures from Giesbrecht. Their English translation is missing a critical line, and a few other parts, I believe, are not in keeping with Gunnerus's substance. In paragraph 4, the italicized phrases are omitted: "... it had four pairs of forelegs *and five pairs of hind legs. These are longer than the forelegs,* consisting of three to four larger segments." Rather than swimming "with the tail down," Gunnerus wrote "on its belly."

The omission of figure numbers by Marshall and Orr hampers the clarification of Gunnerus's description. Gunnerus's Figure 20 is "natural size." He said that *Monoculus finmarchicus* has four pairs of mouthparts; he missed two, but for a century afterward, it was still argued how many of these components were distinct appendages. He recorded the correct number of swimming legs (five pairs), assigning each to its distinct segment. He acknowledged the multisegmented nature of the antennae ("feeler horns"), but said they were too small to count. He could not see eyes or mouth:

> The body was very transparent, shining, smooth, reddish, with a skin much thinner than that of prawns or sea-flies, *Cancer pulex* [amphipod].
>
> I have referred this small creature to *Monoculus* Linn., as it conforms most to this genus, and especially to *Monoculus quadricornis* Linn., as this is figured in natural size in the Stockholm Handlingar for the year 1747 and the months July-Sept., plate VI, Fig. 2; although as I already stated, I was not able to observe any eyes. But since I found no mouth either, which it undoubtedly has, one has no right to deny the presence of eyes, simply because these were not seen under the magnifying glass. Of the crustacean genera, it has the closest resemblance most particularly to the species: *Squilla, Pulex,* and *Locusta.* But as there are no crab-claws (chelas) nor chelate palps, as the crustaceans have, it therefore cannot be referred to them. (Gunnerus 1770)

Altogether, for Gunnerus's time and equipment, this was a stellar performance. Gunnerus said that he used a "Cuf's magnifying glass"; the details he passed on were above anything to that date. Even though we now know there are many similar species, at that locality there is no doubt what species is meant. This was a transcendent zoological/oceanographic moment. Scandinavia had become the world's copepod center, and it would remain so for another generation.

In 1771, Gunnerus was called back to Copenhagen by Johan Friedrich Struensee, Denmark's Minister of State. Struensee wanted to reform the university; this event also impacted J. C. Fabricius and was mentioned by him. Later, Gunnerus said only that the plans were impractical, so he returned to Trondheim in 1772 (Broch 1954). In truth, Struensee's many reforms were very unpopular in some circles; he was forced out of office by a conspiracy of nobles, condemned to death, tortured, and beheaded in 1772. The real world showed Gunnerus quite a counterpoint to his little *Monoculus*—better perhaps to stay with the one-eyed than the no-headed. Linnaeus wrote to Gunnerus in March 1772 that he "was frightfully scared that Hr. Bishop should have been involved in the crisis in Denmark, because such a plague was enough without standing in grace with the accused. . . . It heartily delighted me that Hr. Bishop is returning to the Trondheim Society" (Nordhagen 1950).

Back at Trondheim, Gunnerus was said to be cheerful and eager to return to his marine collecting. On a trip to the open coast near Trondheim, he became sick and died at Kristiansund in 1773. He was fifty-five years old. Agassiz (1853) listed fourteen Gunnerus publications, including studies on fish, hydroids, polychaetes, and sponges. Sivertsen (1961) listed seventeen other zoological papers, many with fine illustrations and critical remarks, adding echinoderms and whales to Gunnerus's range. In his fairly short life, Gunnerus had a wide correspondence, especially with Scandinavian zoologists like O. F. Müller. Gunnerus had gathered about him a small circle of scientists; within marine zoology, perhaps the best known was Peder Ascanius (1723–1803), a Trondheim native, student of Linnaeus, and later a professor (Broch 1954, Wolff 1979).

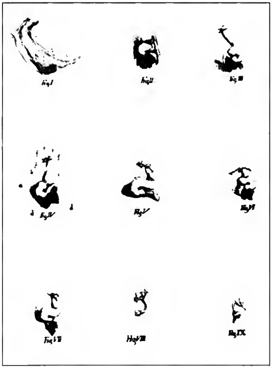
Having just introduced the Dane O. F. Müller, I should state that studies on copepods around this time can conveniently be categorized as pre-Müller, Müller himself, and post-Müller. This will be obvious as the narrative progresses. It is also obvious that there is a strong nucleus of specific copepod interest in the Scandinavian countries. Although the activity in other countries increases, there is never a falling-off of the impressive Nordic contributions.

Joseph Gottlieb Koelreuter

27 April 1733–12 November 1806

Linnaeus's so-called lernaeid from 1767 was seen on a codfish again, this time by Joseph Gottlieb (or Theophil) Koelreuter in 1775, who called it *Lernaea branchiis*. And again, this was "probably *Lernaeocera branchialis*" (see Wilson 1917a). Koelreuter's (1775) Latin title can be paraphrased as "a lernaeid is described which adheres firmly to the gills of cod and which has by chance remained unknown." He included some good figures, one showing the parasite in position on the gill arch. These figures were small and do not reproduce well.

Although for copepodology Koelreuter had only a minor role, his contributions to the understanding and growth of plant science were enormous. He was one of the first to offer proofs regarding sexuality in



(left) "Lernaea branchiis," *a parasite on codfish. From Koelreuter (1775).*

(right) *Joseph Gottlieb Koelreuter (1733–1806). Courtesy of the National Library of Medicine.*

plants, and, inspired by his observations on insect and wind pollination, he conducted many experiments on plant hybridization. Even into the nineteenth century, some persons doubted the existence of sex in plants, and Koelreuter's works were resurrected to dispel such doubts. His experiments foreshadowed the work of Gregor Johann Mendel (1822–1884) (Nordenskiold 1928). Wunschmann (1882) and Olby (1966) both asserted that Koelreuter was "one of the greatest experimental botanists of the eighteenth century."

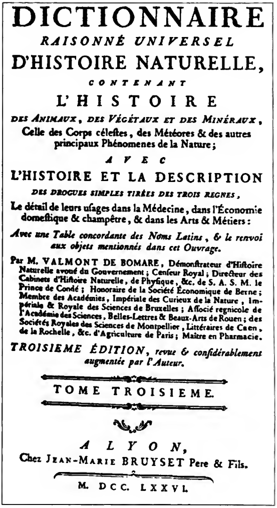
Koelreuter was born in Sulz, Württemberg, on the eastern border of the Black Forest in southwest Germany. Koelreuter's father was an apothecary, and Koelreuter was introduced early to the value and classification of medicinal plants. He studied natural history at the University of Tübingen, in Württemberg, and acquired his M.D. in 1755 with a dissertation on beetles and plants (Wunschmann 1882). His principal teacher there was Johann Georg Gmelin (1709–1755), who had explored Siberia with Bering and others.[4] The University of Tübingen already had a strong tradition in experimental botany (Olby 1966).

Koelreuter's first professional position (ca. 1755) was as keeper of the natural history collections at the Imperial Academy of Sciences in St. Petersburg. His interests there tended toward zoology; however, the academy encouraged him to investigate the then-unproven concept of sexuality in plants.

In 1761, Koelreuter returned to Sulz by way of Berlin and Leipzig, and for some time conducted experiments in his own garden. In 1764, he was appointed Professor of Natural History and Director of the Botanical Gardens at Karlsruhe. It was at Karlsruhe that Koelreuter carried out most of the plant hybridization experiments for which he is rightfully remembered (Wunschmann 1882). Unfortunately, Koelreuter was hampered by the lack of a good microscope, and he was continually frustrated by insufficient finances for his research.

Koelreuter married in 1775 and had six sons and one daughter. He died in Karlsruhe, outliving his wife and eldest son by five years. His name lives on in the northern Chinese plant genus *Koelreuteria,* the golden-rain tree ornamenting gardens the world around.

Agassiz (1853) listed twelve papers by Koelreuter, mostly about Russian fish and zoophytes, but he also published a paper on American insects (Carus 1872). Koelreuter published a large work on cryptogams in 1777 and a general botanical work that increased in pages with several editions from 1761 to 1766.



DICTIONNAIRE
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Avec une Table concordante des Noms Latins, & le renvoi aux objets mentionnés dans cet Ouvrage.
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M. DCC. LXXVI.

Title page of Valmont de Bomare's Dictionnaire Raisonné Universel d'Histoire Naturelle *(1776).*

Jacques-Christophe Valmont de Bomare

17 September 1731–24 August 1807

One very French characteristic of this time was the "encyclopedia," the notion that all knowledge could be circumscribed within the covers of a moderate number of volumes. Buffon's series on natural history was an expression of that optimism (see Chapter 9). Another composition was the scientific "dictionnaire," usually less exhaustive, but sometimes the two formats were indistinguishable. One of the earliest of these was by Jacques-Christophe Valmont de Bomare.

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[4] A nephew, Johann Friedrich Gmelin (1748–1804), edited the thirteenth and final rendering of Linnaeus's *Systema Naturae* in 1793.

Valmont's first studies were at his birthplace, with the Jesuits of Rouen. His father was an attorney with the Normandy parliament, and Valmont was intended also for the bar. Valmont was recognized early on to have an especially good grasp of classical Greek. He moved to Paris in 1750, extending his education there in anatomy and pharmacy, ultimately prevailing over his father's contrary wishes (Hoefer 1866).

Valmont was commissioned by the ministry of war to examine the principal natural history cabinets of Europe, especially as they related to mining and metallurgy. He traveled as far afield as Lapland and Iceland, returning to Paris in 1756. From mid-1757, he lectured publicly, as a private citizen, for more than thirty years on the various branches of natural history and received wide acclaim. By 1764, his lectures were offered three times a week, with that on Sunday offered to the public for free. By 1769, he doubled his presentations, offering instruction to all ages and classes, and both genders. Valmont's successful courses and publications were imitated by others, taking advantage of an insatiable public (Mornet 1911).

Valmont was offered positions in Russia and Portugal, but in spite of his not obtaining support from his own government, he rejected these. He was the unpaid curator of the Prince de Condé's cabinet from 1769. His first publication was a 1758 catalog of a natural history collection for the prince. This was followed by a two-volume mineralogy in 1761 and 1774.

Valmont's "Rational Universal Dictionary of Natural History" was first published in five volumes in 1764. The first of many revised editions came out in 1768–1769 in six volumes. I was able to examine a third edition (Valmont de Bomare 1776) with nine volumes. The fourth edition reached fifteen volumes in 1791, although the fifth, and apparently last, edition was printed in a larger format of only eight volumes, in 1793. There were translations of various versions of the "Dictionary" at least from Denmark, Germany, and Russia.

Valmont de Bomare (1776) had only general references to earlier records of copepods (especially Baker, Geoffroy, and Linnaeus), hidden among the insects ("monocles" and "binocles") and zoophytes ("lernees"). Unfortunately, Valmont's works were not illustrated. He made interesting remarks about the likelihood of monocles taking up the color of the plants they are feeding on, which would explain the color variants. He also said that these "worm-insects" (*vers-insectes*) sometimes impart a blood-redness to the water, "bringing terror to the spirit of the people." "One can only be astonished at the inconceivable quantity of these little animals and their rapid multiplication by the millions." Some species, he noted, live freely in the water, while others live attached to fishes on which they feed voraciously.

In the revolutionary era, the Reign of Terror became suspicious of Valmont's travels, diplomas, and foreign correspondence and brought him hard times. Afterward, by 1796, Valmont was a professor at one of the central Parisian schools as well as an associate member of the Academy of Sciences. Although Valmont did not open new scientific doors, he did make science comprehensible for many others. He was admired for this extraordinary talent and for his "excellent heart, upright spirit, rare integrity, and inexhaustible charity" (Hoefer 1866).

Johan Christian Fabricius

7 January 1745–3 March 1808

Another of Linnaeus's famous pupils was the Dane, or rather the Holsteiner, Johan Christian Fabricius, the son of a physician in Tonder, Duchy of Slesvig. When Fabricius was seventeen he left home to continue his studies in Sweden:

> My heartfelt wish came true when my good father sent me . . . to Uppsala. I was there for two years and they were the most important years of my life. (Fabricius 1805)

Beginning in 1766, and encouraged by Linnaeus, Fabricius applied the new systematic methods to the study of insects that then encompassed copepods.

Fabricius was fond of Linnaeus and left us with some of the best word portraits of his master (Blunt 1971):

> I shall never forget those days, those hours, and it makes me happy whenever I recall them. . . . Few teachers had the good fortune to make so many disciples who all to some extent contributed to the progress of science, and probably no country has sent so many natural historians abroad as has Sweden. Linnaeus was my teacher too, and I acknowledge with deep emotion my great indebtedness to him for his instruction and for his friendship. (Fabricius 1805)

Fabricius also wrote about his closeness to two other Linnaean students. I was surprised to learn that one of these was an American from Philadelphia, Adam Kuhn (1741–1817). There must be a good story here, but since Kuhn did not record any copepods I did

Johan Christian Fabricius (1745–1808). Portrait from Fabricius (1805); signature from Viets (1955).

not research him in depth. It is sufficient to say that upon Kuhn's return in 1768 he was appointed Professor of Botany (the first in America) at the College of Philadelphia. In reverse to his teacher's career, Kuhn veered from botany and ended as an influential physician. Undoubtedly, however, he had a role in the direct delivery of Linnaean principles to the New World (Goode 1901b). Kuhn probably met Ellis in London, and for a time they corresponded and exchanged seeds. However, the relationship apparently soured, revealed by a note that time has rendered amusing:

> Dr. Kuhn is one of those American chiefs that despise us Englishmen. I sent him some seeds of the *Rheum palmatum* by a friend and he had not the decency to thank me; but his German pride will do him no service, for, thank God, we shall now humble those American revolters. He is, to my knowledge, infinitely obliged to you: without your care in cultivating his mind he would have been a mere savage. (Ellis to Linnaeus, 1770, qtd. in Kelly 1914)

Kuhn sent Linnaeus some seeds from a North American perennial herb, false boneset, to which Linnaeus gave the name *Kuhnia*.

Fabricius was appointed a professor at Copenhagen in 1770 and finally, in 1775, at Kiel, which at that time was under the Danish crown. He held this post until his death in 1808. To distinguish J. C. Fabricius from another Dane, Otto Fabricius, Müller referred to the former as "Fabricius Kiloniensis," the Fabricius from Kiel. Unfortunately, Fabricius did not find many opportunities at Kiel; he especially deplored the lack of a good library. He therefore spent most of his late years in Paris where he was highly regarded (Nordenskiold 1928).

Fabricius was one of those surprising early scholars who seemed to go everywhere and meet everybody. He collected friends as well as insects, rearranged museums, and captivated his colleagues in Germany, Holland, Scotland (where his brother was a medical student), England, France, Italy, Switzerland, Austria, Norway, Sweden, and Russia (Bryk 1945). Among the many notables he mentioned were Cuvier, Etienne Geoffroy Saint-Hilaire (1772–1844; not the earlier entomologist Etienne Louis Geoffroy of *Binoculus* fame), and Scopoli. Tuxen (1973) said that Fabricius and Latreille were close friends. At the British Museum, Fabricius became friends with his counterpart Solander and met Banks, Ellis, Pennant, and others

> whose homes, libraries, and collections were all open to me. . . . I stayed in London for the most part of the year 1768. In June, Banks and Solander prepared for their trip around the world with Captain Cook; that caused a kind of emptiness for me in London. In the spring, as long as the ship lay in the Thames, we visited it quite often in order to fix it in the best way. (Fabricius 1805)

When Fabricius returned to Copenhagen, there was a crusade to reorganize the university, and everything academic was to go into an academy:

> Bishop Gunnerus was called to Copenhagen to give the Academy a new arrangement wherein I also would be appointed. Gunnerus, as he knew and enjoyed natural history, wanted to do the best for me. . . . However, . . . Gunnerus went back to Trondheim, the Academy stayed as it was, and I was appointed Professor.
>
> From 1772 to 1775 I stayed in Copenhagen during the winters and spent the summers in London. My

friends, Solander and Banks, had returned from their trip around the world and had brought many things from nature, and insects. Here I lived content. With Banks, Hunter, and Drury I found enough objects to keep me busy and all the help I needed. (Fabricius 1805)

Fabricius's (1775) first zoological work was *Systema Entomologiae.* Linnaeus had described more than two thousand insects, Fabricius more than ten thousand. In this work, Fabricius included eight classes of insects, the third being Synistata, characterized by having four palps at the mouth. Many terms are used that may not be comparable to similar terms used today, and without illustrations, much of this is now perplexing. There were many genera within the Synistata, one of which was *Monoculus,* having the four posterior palps ear-shaped and the antennae often branched. This is not very useful but indicates the level of details that differentiated the various genera. Remember also that most of these genera held species that are now placed in different classes, subclasses, or orders.

The first *Monoculus* species is the cladoceran *Polyphemus.* The second species is *Monoculus piscinus* (and its synonym *Binoculus* Geoffroy) from Linnaeus's twelfth edition, a copepod later determined to be identical with Müller's *Caligus curtus.* There followed within *Monoculus* one each branchiopod, cladoceran, and ostracod, and two copepods.

The next copepod was *Monoculus pediculus* from European fresh waters, first mentioned in Linnaeus's late edition; this, too, is likely a caligid copepod, an external parasite on fish. The last copepod was the ill-fated *M. quadricornis* from European stagnant waters and, Fabricius says, already reported by Geoffroy, Baker, Joblot, De Geer, Roesel, and Leeuwenhoek. Again, not much; but any naturalist armed with this record who took the trouble to look in the waters would immediately have seen species that were not listed. In that sense it was useful.

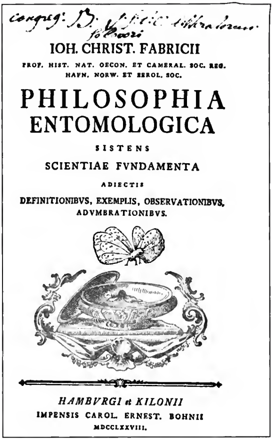
I am puzzled by the omission of *Monoculus finmarchicus.* Perhaps Fabricius only listed species he had seen. We have already seen that he was personally acquainted with Gunnerus and knew of his zoological contributions.

Fabricius's (1778) *Philosophia Entomologica* was the first textbook of entomology and introduced an improved classification based on mouthparts; this kept natural groups together that Linnaeus's system had separated according to wing structures. Fabricius's small book also covered theoretical principles of study, nomenclature, description, and classification. He inventoried seventy-seven entomologists, presenting in all capital letters the names of the most important. Of those seventy-seven, we cover in this book (and I list them here following Fabricius's capitalization style) GESSNER, Moffett, Hooke, Swammerdam, Blankaart, Leeuwenhoek, RAY, LINNE, ROESEL, De Geer, Scopoli, GEOFFROY, and Müller. It is clear that Fabricius evaluated these authors because of their work with insects "proper," not as we do because of their association with copepods.

The *Philosophia Entomologica* reviews the major classification systems. Linnaeus's twelfth edition of 1767 indicated the following hierarchy:

Class Insecta, Order Aptera
  a. 6 legs
  b. many legs
    alpha. head united with thorax
    beta. head and thorax distinct

Presumably, the free-living copepods would have been in the beta group.



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IOH. CHRIST. FABRICII

PROF. HIST. NAT. OECON. ET CAMERAL. SOC. REG.
HAFN. NORW. ET BEROL. SOC.

PHILOSOPHIA
ENTOMOLOGICA

SISTENS

SCIENTIAE FVNDAMENTA

ADIECTIS

DEFINITIONIBVS, EXEMPLIS, OBSERVATIONIBVS,
ADVMBRATIONIBVS.

HAMBVRGI et KILONII
IMPENSIS CAROL. ERNEST. BOHNII
MDCCLXXVIII.

Title page of J. C. Fabricius's Philosophia Entomologica ***(1778).***

Fabricius (1778) informs the reader which authors to look to for particular insect groups, for general information about insects, and for specific geographic regions. He has a pragmatic guide to published insect illustrations arranged according to crude, valuable, outstanding, and worthless. Of groups that may contain copepods, only De Geer is mentioned, with *Monoculus.* This little book fairly oozes with information. It is not surprising that Zimsen (1964) called it "the most important and significant work within Danish entomological science."

That little attention had been given to copepod details is evident in Fabricius's basic comments on morphology. There simply was not much available for a reviewer to review. *Monoculus* eyes are "up front" and set into the shell. The *Monoculus* antenna is overlooked, although this appendage is described for several other crustaceans. Mouthparts, given in relatively great detail for other groups, are overlooked for *Monoculus.* Of the feet, there is nothing regarding number or location, but, surprisingly, a dual use is indicated as respiration ("branchiales") and swimming. Later in the book he alludes to *Monoculus* as "polypodes," but not with six, eight, or chelated feet.

Of reproduction and growth, Fabricius (1778) states that insects in general are mostly annual, just barely living through the winter, except for the aquatic forms such as *Cancer* (crabs), *Astacus* (crayfish), and *Monoculus.* These, with difficulty, throw off the old shell each year. Of all insects, they have the longest life spans.

There is a curious list of "absurd names, given by ignorant persons." One, for example, is *Abyssus Satanae,* which could only be translated as "the devil from the deep." I don't know why Fabricius did not like this name; it is as respectable as many other names. Perhaps it is a reflection of his very religious times. In any case, he equates it to *Monoculus,* without reference. According to Geoffroy (1799), Agassiz (1853), and Hagen (1862), this "ignorant person" was Urban Hiaerne, who published several pre-Linnaean papers on insects (in the broad sense). The offending name was assigned to the common cladoceran water-flea, neither abyssal nor satanic, nor a copepod. Urban Hiaerne (1641–1724) was a respected Swedish physician, chemist, man of letters, and teacher. His best-known student was Johann Georg Gmelin (1674–1728), the founder of a famous German dynasty of scientists (Lindroth 1952). His son, of the same name, was Koelreuter's teacher.

Fabricius (1778) believed that insect habitat differed mainly according to the different foods, both for the larvae and the adults. He specifically puts *Monoculus* in the sea, in salt water, along with *Cancer, Astacus, Pagurus, Oniscus,* and *Scyllarus.* And with *Gammarus, Monoculus* also inhabits marshes and spacious muddy places full of stagnant water that occasionally dry up in summer. There is no indication where he obtained the reference for the marine *Monoculus*—perhaps Gunnerus (1770).

Fabricius considered classification indispensable but not the sole aim of science. Many important entomological works came from Fabricius, and he dominated the field for the two decades after Linnaeus (Tuxen 1973). His own insect collection was probably the finest of that time, and many foreign collections received his imprint. The extraordinary number of Fabricius type species prompted the recataloging of the large number of existing specimens (Zimsen 1964). Most are now in the Zoological Museum of Copenhagen, but large numbers were also in the British Museum and at Kiel. Among the insects were 177 type-specimens of crustaceans, but not one is a copepod.

Fabricius described a copepod in a long record of a trip through Norway, published in 1779 (Vervoort 1986a). This copepod was *Lernaea pinnarum* Fabricius, 1779. Wilson (1917a) equated this to *Clavella uncinata* (Müller, 1776), although he should have referred it even farther back to *C. adunca* (Strøm, 1762) (see Kabata 1979).

Fabricius may have skirted some danger in the wake of the Struensee downfall, but he definitely asked for adventure in Revolutionary France:

> In 1790 accompanied by my wife and daughter I went to Paris partly because I knew . . . cabinets were to be found with a considerable number of insects which I as yet did not know, and partly because I wished more information about the new order of things which followed the revolution. I was well-received with excellent respect and friendliness. [Bosc and others] . . . opened up all their collections and with their friendship and goodwill made my stay comfortable as well as instructive. I also made the acquaintance of the head men of the revolution and especially with the later, and not so lucky, Roland family. . . . I found myself in the National Assembly and also in the Jacobin Club and saw all the scenes from the revolution. (Fabricius 1805)

In later years, Fabricius replaced a popular "chain" concept of progressively "higher and higher" organisms with a multibranched concept, in a small way preparing the ground for the evolutionary concepts a half-century in the future. He, as did most of his contemporaries, considered man as the most refined outcome of nature, but Fabricius accepted a relationship of man to other animals whereby all are subject to the same natural laws. His discussions with the near-evolutionist Lamarck probably influenced both men; their published comments about the mutability of species, through hybridization and the influence of climate and food, were essentially concurrent. Lamarck did not publish his famous doctrine until 1800 (Jespersen 1946).

> During numerous travels abroad [Fabricius] had cultivated his far-reaching interests, which extended far beyond natural history, and as a professor he had given lectures on natural history to the educated public at Kiel. His papers . . . are popular and easy to understand. Also the philosophy and views on life in the Age of Enlightenment are reflected in his works. His views . . . are filled with optimism. (Jespersen 1946)

Fabricius's daughter died from an accident that occurred during a Paris sojourn. He had two sons who studied medicine.

Latreille published a biographical notice of his friend Fabricius in 1808 (Jespersen 1946). The portrait that I have appended is from the rare book by G. L. Lahde, the Danish court engraver, and was made from life. Fabricius summarized his life as:

> Constant occupation with an inexhaustibly pleasant science that I, not without luck, reworked, maintained my enterprise, widespread peace, and bliss over my whole career. (Fabricius 1805)

* * *

The commentary on Fabricius's life followed easily from Linnaeus, but it has taken us out of the copepod chronology. The next chapter continues to record copepod contributions from Scandinavia, from O. F. Müller, who was the center of and the reason for a golden age of Danish natural history.

7

DISCOVERED IN OUR NATIVE LAND

In the Age of Enlightenment the study of living nature, like all other cultural happenings, was greatly influenced by the general state of culture and the prevailing ideas, just as will always be the case. The guiding ideas, which science always requires for its proper growth, were not lacking.... The rational arrangement of living things was regarded as proof of Providence. Consequently, one could learn about God's wisdom and glory by studying nature; and what was more natural than to devote oneself to such a study, fully harmonizing as it did with the piety of those days? By that means, scientists in their labours united their urge for research with their religious views....

Another important incentive to the study of nature was the prevailing utilitarianism. No one doubted that everything had been created for the pleasure and benefit of mankind. This anthropocentric attitude is to be found everywhere....

There is thus ample evidence of the great zeal of the authorities in putting life into naturalistic research. It is true that the idea behind it was to obtain quick, practical results and doubtless also to gain kudos for the Crown; nevertheless, its attitude engendered much interest in natural history and made the study of it attractive and distinguished. Under these favorable conditions it is no wonder that those who cultivated natural history became objects of applause and flattery. Their branch of science, and with it they themselves, rose in esteem, and the entire social position of its devotees became elevated, with the result that the conditions under which nature studies were carried on became unusually good....

Simultaneously, natural science rose to become an independent line. It was cut loose from its dependence on its quondam mother-science, medicine, and its votaries became specialists, natural historians, who moreover were able to confine themselves to a more specialized line, chiefly botany, which had become a particular favorite as a result of the work of Linnaeus. What is more, natural history, like the period as a whole, emancipated itself from tradition and prejudice and emerged into the age of free research.

—JEAN ANKER, *Otto Friderich Müller's Zoologia Danica*

IN THE LAST QUARTER of the eighteenth century, the principal armament in a naturalist's arsenal was Linnaeus's *Systema Naturae,* most commonly the tenth through the thirteenth (and last, 1788–1793) editions. Besides being a worthwhile catalog and brief description of all known plants and animals, application of this information quickly led the way into unknown material, remaining confusions, and unnaturally combined groups that begged for anatomical studies. A number of workers thus leapt into these zoological recesses. Even though Linnaeus's relative coverage was good, there were obviously many more insects to be described; we have mentioned J. C. Fabricius in this regard. Copepods were not well understood and were only incidental subjects of broader studies on insects or worms. This changed in a very short amount of time. For this transformation, we look again to Scandinavia and to the life and work of Otto Friderich Müller, the foremost representative of the Linnaean period in Denmark (Snorrason 1974).

Otto Friderich Müller

2 March 1730–26 December 1784

Otto Friderich Müller, or in the Latin version "Otho Fridericus Müller," the son of a court trumpeter who had come from Germany, was born in Copenhagen. He began his education, like so many contemporaries, as a theologian. No doubt the theological schools were the better schools, in general, and certainly the more "respectable." Müller turned from theology to law, then finally to natural history. Although not directly a pupil of Linnaeus, Müller was greatly influenced by him and clearly acknowledged this debt. Müller's studies, however, had a marked independence and originality.

Müller was admitted to the University of Copenhagen in 1748 but never earned a degree. He did well in a variety of subjects, especially music, theology, and sciences, and he was recruited in 1753 to tutor the young son of a noble family. This was an incredibly favorable appointment, enviable in any era. Müller lived with the Schulin family at their estate at Frederiksdal, one of the idyllic spots near Copenhagen. During nearly two decades with the young count, Müller had many opportunities for local field observations, European travels, and connections to court, clergy, and academia.

Müller began his own serious research in 1758, using Linnaeus's works as a guide. Encouraged by the family, Müller taught natural history to his student and to himself. In league with the Schulins, Müller could borrow books he was unable to purchase; Müller especially noted a Pliny book and the insect illustrations of Roesel. Müller bought his first two microscopes in 1760 and 1761, both made by Watkins (see p. 168, Figs. 119 and 120, in Clay and Court 1975); he said the best overall was "the simple English microscope." A small compound microscope, probably also a Watkins, was incorporated into C. F. Müller's handsome vignette along with happy assistants (cherubs) and other tools of the trade (books, chart, dredge, rope, oar, boat-hook, collecting jars, data sheets) on the title pages of *Zoologia Danica* (Zoology of Denmark) volumes, published from 1788 to 1806 (and reproduced here on the title page of this volume); this style of microscope seen in the vignette is also pictured in Clay and Court (1975). Correspondence with Linnaeus was begun in 1762. No undergraduate could have dreamed of a better position, and even better was to come.

From 1763 to 1764, Müller was with his young pupil in Leipzig, where he published his first papers, on the insects and plants of Frederiksdal. Between visits to relatives, diplomats, professors, and museums in the "Little Paris" that was Leipzig, Müller was able to add immeasurably to his knowledge of insects. His diary and daily letters to Countess Schulin survive as a detailed record of Müller's early days (Anker 1943).

From 1765 to 1767, the duo traveled through Germany, Switzerland, Italy, France, and Holland, meeting several leading naturalists, physical scientists, and philosophers. At the time, Müller was more interested in botany than insects, although he was turning toward the lower invertebrates.

In Switzerland, Müller met Albrecht von Haller (1708–1777), who was to become a lifelong friend; through von Haller, Müller met other Swiss naturalists: Horace Benedict de Saussure (1740–1799); Charles Bonnet (1720–1793), who became another lifelong friend; and Abraham Trembley (1700–1784). Von Haller was preeminent in many fields, including anatomy, physiology, botany, poetry, and medicine (Nordenskiold 1928). He had been a pupil of Boerhaave at the University of Leiden. Bonnet, entomologist and philosopher, had been a corresponding student of Réaumur; de Saussure, remembered for being the first user of the words "geology" and "geologist," was Bonnet's nephew by marriage and his adopted son (Miall 1912, Fulton and Thompson 1947). We will remember Bonnet best for his direct influence on Jurine, one of the great copepodologists of the coming century. Trembley will always be recalled for his pioneer studies on *Hydra*.

At Ferney, near Geneva, Müller and Count Schulin paid their respects to Voltaire (1694–1778), who had made a noteworthy visit to Boerhaave many years before. In France, Müller met some of that country's famous naturalists, including Duhamel de Monceau and Bernard de Jussieu (Linnaeus's friend), both of whom proposed Müller as a corresponding member of the Académie des Sciences (not official until 1773). Within his insect sphere, he met E. L. Geoffroy, already mentioned in a copepod context, and Michel Adanson (1727–1806), a pioneer in African insects. These experiences could not be bought, nor were they always available even to the most noteworthy men. Müller had seen with his own eyes the cream of foreign science, especially natural history, and had met many important participants, two of whom became friends. And this made Müller an "international" scientist (Anker 1943).

Quo docili natura parens lætatur alumno,
MULLERUM hic civem, Dania, læta vide!
Ille, tuas dum monstrat opes terræque marisque,
Participem ſamæ te ſacit eſſe ſuæ
Cornel. Hoyer. del
Meno Haas ſculps Hafniæ

Otto Friderich Müller (1730–1784). From Anker (1950).

Müller had the young count back in Copenhagen in April 1767, in time for the May coronation of Christian VII and Caroline Mathilde. Christian VII was the dangerously insane king who had Struensee beheaded a few years later, and who finally was deposed with a son as regent.

Albrecht von Haller and J. E. Gunnerus joined Müller's list of correspondents in 1767; a decade later they were joined by J. A. Scopoli and Johann Hermann.

Müller left the Schulin household in 1771, when the young and well-educated count was twenty-four years old. At the recommendation of Georg Christian Oeder (1728–1791), Müller was given a position in the state archives. This was in the turbulent time of Struensee, and Müller was soon caught up in the general purge and dismissed, although he received a small pension and retained a capacity to receive later state support. A 1773 marriage to a wealthy Norwegian widow enabled him to continue and expand his research. With the marriage came an estate at Drobak, Oslo Fjord, on Norway's southern coast, where Müller soon spent his summers.

Müller dredged and collected along the coast of Denmark and southern Norway, usually in small boats along the shore. A unique record of this pioneer work is preserved in the foreword of *Zoologia Danica* (1788a); essential parts of this were translated to English by Wolff (1967). Although dredges had been used before Müller, none had employed them at the Müller scale.

Drobak, on the east side of Oslo Fjord, was an exceptionally good spot for field work. These summer excursions added large numbers of specimens to Müller's growing *Zoologia Danica*. Müller always had an entourage that included painters, engravers, and students. He attracted the right students by way of newspaper notices, paying their way from Copenhagen or Oslo during the unforgettable experience. One student, at Müller's suggestion and recommendation, went to study with Linnaeus. Müller also collected the flora of Denmark, not knowing that he would become the principal in that enterprise as well. His last summer trip to Drobak was in 1778, after which he was much afflicted with arthritis. He then collected only on the coasts of Denmark proper, including its islands (Anker 1950).

Müller was among the first Danes to aim a microscope at aquatic plants and animals. He was one of the most eminent taxonomists of his day. However, he emphasized that classification was not the goal in itself, but rather only necessary to keep track of that which is studied from every angle for deeper meaning. Müller dissected some invertebrates, looking for various organs or parasites; for this work he mentioned scissors, forceps, and "magnifying glass." He used a small brush to catch and hold small animals under the microscope. Müller had every type of microscope then available, but he mostly used the simple varieties. He said one needed long practice and great patience and should only use the compound scope sparingly, since the image, though larger, was less distinct (Anker 1950).

In keeping with his time, Müller believed each species was eternal and unchangeable. He seldom theorized, instead emphasizing only facts from his observations. From 1774 until 1784, he had an amazing and steady output of publications while his reputation grew at home and abroad. In the fields neglected by Linnaeus and his followers, Müller made strong contributions to knowledge of Infusoria, Hydrachnidae, Tardigrada, Vermes, Mollusca, and, most important in our context, his Entomostraca. Müller published a two-volume monograph on worms and mollusks during 1773–1774. In 1786, his friend Otto Fabricius finished Müller's important work on Infusoria. Agassiz (1853) provided references to thirty-eight Müller zoological publications, all obscure and most about insects; a few may have brief references to copepods not mentioned in this review.

The *Prodromus*

Müller's greatest work, *Zoologia Danica,* is best understood after a look at its scientific inspiration, the justly famous *Flora Danica.* In 1754, the Danish government called the German botanist Georg Christian Oeder to Copenhagen, upon recommendation by his professor Albrecht von Haller. Oeder's duties included the formation of a botanical garden, a botanical library, and the publication of *Flora Danica* (1761–1871), a superlative state-supported monograph of plants from all the Danish lands. Müller's life was tied to this series in two ways: the series gave Müller the idea to have a counterpart series on Danish animals (particularly the overlooked marine invertebrates), and after other duties took Oeder away from the *Flora* in 1774, Müller himself became author and publisher.

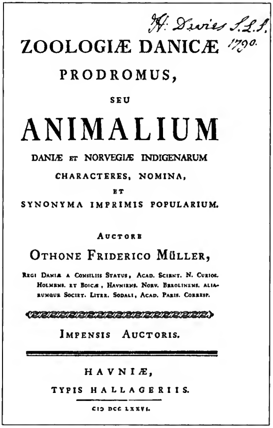
Müller's plan was to describe all the Danish-Norwegian fauna in a fashion similar to *Flora Danica,* with the name of *Zoologia Danica.* In 1774, he made a successful proposal to the Crown for support of the needed zoological collections and printing costs. Müller would get only a certain number of copies of the finished work, and these he would be able to sell. It is stated now without surprise that *Zoologia Danica* was never a money-making affair, which explains why there are relatively few copies in existence today.

By 1776, Müller was well on his way toward securing an initial few subscribers by way of a *Prodromus,* or forerunner of the planned zoological series. In addition, he sent notices to all his correspondents and placed advertisements in major northern European journals. The publication was to be available in Danish, German, or Latin, a pledge partially kept. A part of the plan that was fulfilled was the production of two versions, an expensive one with hand-colored plates and a standard one with uncolored plates. Wolff (1967) reproduced a selection of the magnificent colored plates.

The *Prodromus* (Müller 1776) was a concise taxonomic survey, in Linnaean form, of all Danish and Norwegian animals known to Müller. It had no illustrations but included brief Latin descriptions, some synonyms, literature references, Danish and Norwegian names, and sometimes Lapp, Icelandic, or (from Otto Fabricius) Greenlandic names. All names were indexed. Species not in Linnaeus's books were indicated by symbol, as were all species newly named by Müller. In total, there were 3,101 Danish species, with over 800 "new." Of the marine animals, 157 species had come from Oslo Fjord.

A Müller letter to Linnaeus in April 1776 said that he had expected to enclose a copy of the *Prodromus,* but last-minute printer's problems were delaying it. At the end of May, Müller was able to send Linnaeus "the first copy." The government did not consider this small book part of the official *Zoologia Danica* program, in spite of Müller's protestations that "this handbook is a useful and necessary forerunner to the *Zoologia Danica*." Müller therefore sold the *Prodromus* to the government, as well as to anyone else, for 1⅔ rixdollars each (Anker 1950). Lest there be a misunderstanding, prominently printed on the title page was "Impensis Auctoris" (at the author's expense).

As author, Müller proudly listed his affiliations: "Advisor to the King of Denmark, Member of the



H: Davies F.L.S.
1790.

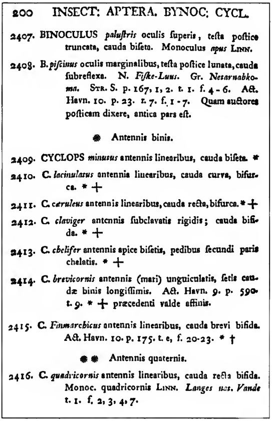
ZOOLOGIÆ DANICÆ
PRODROMUS,
SEU
ANIMALIUM
DANIÆ ET NORVEGIÆ INDIGENARUM
CHARACTERES, NOMINA,
ET
SYNONYMA IMPRIMIS POPULARIUM.

AUCTORE
OTHONE FRIDERICO MÜLLER,
REGI DANIÆ A CONSILIIS STATUS, ACAD. SCIENT. N. CURIOS.
HOLMENS. ET BOICÆ, HAVNIENS. NORV. BEROLINENS. ALIA-
RUMQUE SOCIET. LITER. SODALI, ACAD. PARIS. CORRESP.

IMPENSIS AUCTORIS.

HAVNIÆ,
TYPIS HALLAGERIIS.
CIↃ DCC LXXVI.

Title page of Müller's Prodromus *(1776).*



200 INSECT: APTERA. BYNOC: CYCL.

2407. BINOCULUS *paluſtris* oculis ſuperis, teſta poſtice truncata, cauda biſeta. Monoculus *apus* LINN.

2408. B. *piſcinus* oculis marginalibus, teſta poſtice lunata, cauda ſubreflexa. N. *Fiſke-Luus.* Gr. *Nesarnabkoma.* STR. S. p. 167, 1, 2. t. 1. f. 4-6. Act. Havn. 10. p. 23. t. 7. f. 1-7. Quam auctores poſticam dixere, antica pars eſt.

* Antennis binis.

2409. CYCLOPS *minutus* antennis linearibus, cauda biſeta. *

2410. C. *lacinulatus* antennis linearibus, cauda curva, bifurca. * +

2411. C. *cæruleus* antennis linearibus, cauda recta, bifurca. * +

2412. C. *claviger* antennis ſubclavatis rigidis; cauda bifida. * +

2413. C. *chelifer* antennis apice biſetis, pedibus ſecundi paris chelatis. * +

2414. C. *brevicornis* antennis (mari) unguiculatis, ſetis caudæ binis longiſſimis. Act. Havn. 9. p. 590. t. 9. * + præcedenti valde affinis.

2415. C. *Finmarchicus* antennis linearibus, cauda brevi bifida. Act. Havn. 10. p. 175. t. e, f. 20-23. * †

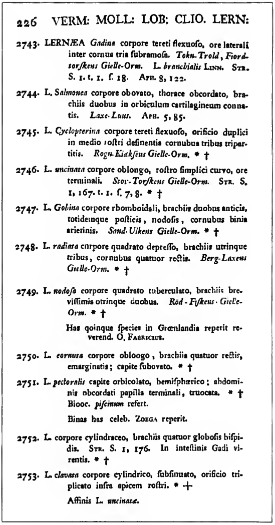
* * Antennis quaternis.

2416. C. *quadricornis* antennis linearibus, cauda recta bifida. Monoc. quadricornis LINN. *Langes nat. Vande* t. 1. f. 2, 3, 4, 7.

Müller's copepod species listed in the Prodromus *(1776).*

Academies of Science, Nature, and Research of Stockholm, Bohemia, Copenhagen, Norway, and Berlin, and to other Societies of Literature; a Corresponding Member of the Academy in Paris." (Added on the *Zoologia Danica* were the Societies of Bonn, Bern, Danzig, and London.) Müller dedicated the *Prodromus* to Frederick, His Serene Highness and Ruler of Denmark, Norway, and Holstein. Frederick was only eight years old, and it would be another eight years before he became regent for his unbalanced father. Frederick ruled until his death in 1839.

The *Prodromus* summarized the animal kingdom's chief divisions by classes, orders, and families. The first four classes (vertebrates) sensibly followed Linnaeus, especially since this was unfamiliar ground to Müller. With the last two classes, Insecta and Vermes, Müller became decidedly independent because of his experience and focused studies. In the Insecta he had seven orders, following Linnaeus and E. L. Geoffroy, whom Müller acknowledged as a special entomological teacher (see Anker 1950); the first six orders are close to today's usage. It was in the last order, the Aptera, that Müller introduced important changes, with a new practical taxonomy based on external characters of the forms.



226 VERM: MOLL: LOB: CLIO. LERN:

2743. LERNÆA *Gadina* corpore tereti flexuoſo, ore laterali inter cornua tria ſubramoſa. *Tokn-Trold, Fiord-torſkens Gielle-Orm.* L. *branchialis* LINN. STR. S. 1. t. 1. f. 18. APH. 8, 122.

2744. L. *Salmonea* corpore obovato, thorace obcordato, brachiis duobus in orbiculum cartilagineum connatis. *Laxe-Luus.* APH. 5, 85.

2745. L. *Cyclopterina* corpore tereti flexuoſo, orificio duplici in medio roſtri deſinentis cornubus tribus tripartitis. *Rogn-Kiakſens Gielle-Orm.* * †

2746. L. *uncinata* corpore oblongo, roſtro ſimplici curvo, ore terminali. *Stor-Torſkens Gielle-Orm.* STR. S. 1, 167. t. 1. f. 7, 8. * †

2747. L. *Gobina* corpore rhomboidali, brachiis duobus anticis, totidemque poſticis, nodoſis, cornubus binis arietinis. *Sand-Ulkens Gielle-Orm.* * †

2748. L. *radiata* corpore quadrato depreſſo, brachiis utrinque tribus, cornubus quatuor rectis. *Berg-Laxens Gielle-Orm.* * †

2749. L. *nodoſa* corpore quadrato tuberculato, brachiis breviſſimis utrinque duobus. *Rød-Fiſkens-Gielle-Orm.* * †

Has quinque ſpecies in Grœnlandia reperit reverend. O. FABRICIUS.

2750. L. *cornuta* corpore oblongo, brachiis quatuor rectis, emarginatis; capite ſubovato. * †

2751. L. *pectoralis* capite orbiculato, hemiſphærico; abdominis obcordati papilla terminali, truncata. * † Binoc. *piſcinum* refert.

Binas has celeb. ZOEGA reperit.

2752. L. corpore cylindraceo, brachiis quatuor globoſis hiſpidis. STR. S. 1, 176. In inteſtinis Gadi virentis. * †

2753. L. *clavata* corpore cylindrico, ſubſinuato, orificio triplicato infra apicem roſtri. * +

Affinis L. *uncinatæ.*

Müller's Aptera contained four groups: Nuda (naked forms), Squamata (scaled forms), Crustacea (crusted forms), and Testacea (shelled forms). The last two groups were mostly crustaceans. New genera and species were added to each of these groups.

In the Class Vermes, Müller introduced radical changes in classification, including the new order Infusoria, and a large number of new species.

Beyond the intention of summarizing *Zoologia Danica,* which was well under way, the *Prodromus* stood by itself as the first handbook of its kind and, for many years, the best account of the region's fauna.

Within the crustaceous Aptera, Müller had only one correct and all-copepod genus, the new *Cyclops.* There were two copepod "genera" within the testaceous Aptera—both new, and both erroneous in that they were based not on strange new adults, as Müller thought, but on juvenile stages: *Amymone* and *Nauplius*. Remaining from this nomenclature, however, is the accepted term for the earliest larval stage of crustaceans, the "nauplius." Müller had a fourth genus, *Binoculus*, also testaceous, that was primarily for the noncopepod argulids. In the *Prodromus*, Müller actually added a copepod to *Binoculus*. Finally, there was a fifth copepod genus—*Lernaea*—within the molluscan Vermes. Also within Vermes, but under Cellulana, was the potentially copepod-containing genus *Pennatula*, although Müller never reported a copepod species of this kind.

Müller did not improve on Linnaeus's zoophyte scheme. Rather than "zoophytes," he called most of those Cellulana, or compound animals, enclosed in cells and propagated by means of buds. *Pennatula* were listed right alongside sponges.

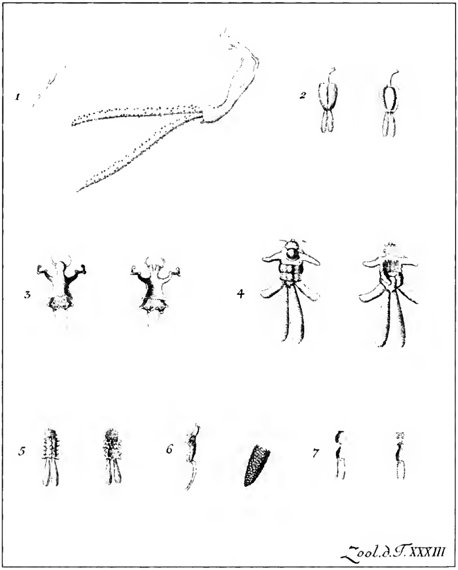
Each species in the *Prodromus* was given a consecutive number, enabling one to unequivocally refer to each. Number 2377 was *Nauplius bractiatus*, not in Linnaeus, and offered for the first time by Müller; it was "the glittering nauplius, a shellfish with a variably-round shell"—like a second *Nauplius* species, *N. saltatorius*, Number 2378, essentially dead on arrival.

Numbers 2379–2381 were *Amymone satyra*, *A. silena*, and *A. fauna*. These were inspired by Müller's examination of other nauplii; they have no taxonomic status today.

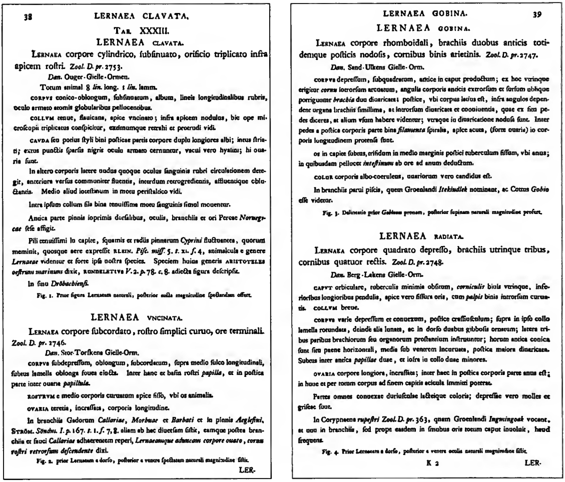
The one copepod that Müller placed within *Binoculus*—*B. piscinus*, his Number 2408—was accompanied with the notation that it was Strøm's codfish-louse from 1762 and Strøm's *Monoculus* from 1770. We have already indicated in Strøm's chronology that Müller (1785) later renamed them again for his new genus *Caligus*.

Of the eight *Cyclops* species in the crustaceous Aptera, Müller noted two kinds: those with two antennae (i.e., one pair) and those with four antennae (two pairs). Numbers 2409–2415 possessed two antennae: *C. minutus*, *C. lacinulatus*, *C. caeruleus*, *C. claviger*, *C. chelifer*, *C. brevicornis*, and *C. finmarchicus*. This last was equated to Gunnerus's *Monoculus finmarchicus* by reference; that it was not Gunnerus's species caused a century of confusion. The final *Cyclops* species—*C. quadricornis*, as the "four-horned" name implies—was the sole member of the group with four antennae and by reference the same species reported by Lange (1756). Except for *C. finmarchicus* and *C. quadricornis*, these were all Müller species. None was mentioned in *Zoologia Danica*. No additional information was provided for these species until Müller's (1785) *Entomostraca*; the species are discussed in that context below.

Müller's (1776) last eleven copepods (Numbers 2743–2753), briefly described, were in the genus *Lernaea*, and, as he indicated, all except the last one were known to others: *L. gadina*, *L. salmonea*, *L. cyclopterina*, *L. uncinata*, *L. gobina*, *L. radiata*, *L. nodosa*, *L. cornuta*, *L. pectoralis*, *Lernaea* corpore cylindraceo, and *L. clavata*. It must be noted that the host species were mentioned only indirectly by way of the quaint common names for their parasites. Cross-reference to the common names of fish in both Müller (1776)



Müller's parasitic copepods from Zoologia Danica, *Plate 33 (1788a).*



38 LERNAEA CLAVATA.

TAB. XXXIII.

LERNAEA CLAVATA.

LERNAEA corpore cylindrico, ſubſinuato, orificio triplicato infra apicem roſtri. *Zool. D. pr.* 2753.

Dan. Ouger-Gielle-Ormen.

Totum animal 8 *lin.* long. 1 *lin.* latum.

CORPVS conico-oblongum, ſubſinuatum, album, lineis longitudinalibus rubris, oculo armato atomis globularibus pellucentibus.

COLLVM tenue, flauicans, apice vncinato; infra apicem nodulus, hic ope microſcopii triplicatus conſpicitur, extimumque retrahi et protrudi vidi.

CAVDA ſeu potius ſtyli bini poſticae partis corpore duplo longiores albi; intus ſtriati; extus punctis ſparſis nigris oculo armato cernuntur, vacui vero hyalini; hi ouaria ſunt.

In altero corporis latere nudus quoque oculus ſanguinis rubri circulationem detegit, anteriora verſus communiter fluentis, interdum retrogredientis, affluentique obluctantis. Medio aliud inteſtinum in motu periſtaltico vidi.

Intra ipſum collum fila bina tenuiſſima motu ſanguinis ſimul mouentur.

Antica parte pinnis inprimis dorſalibus, oculis, branchiis et ori Percae *Norvegicae* ſeſe affigit.

Pili tenuiſſimi in capite, ſquamis et radiis pinnarum *Cyprini* fluctuantes, quorum meminit, quosque aere expreſſit KLEIN. *Piſc. miſſ.* 5. *t.* XI. *f.* 4, animalcula e genere *Lernaeae* videntur et forte ipſa noſtra ſpecies. Speciem huius generis ARISTOTELES *oeſtrum marinum* dixit, RONDELETIVS *V.* 2. *p.* 78. *c.* 8. adiecta figura deſcripſit.

In ſinu *Dröbachienſi.*

Fig. 1. Prior figura Lernaeam naturali, poſterior aucta magnitudine ſpectandam offert.

LERNAEA VNCINATA.

LERNAEA corpore ſubcordato, roſtro ſimplici curuo, ore terminali. *Zool. D. pr.* 2746.

Dan. Stor-Torſkens Gielle-Orm.

CORPVS ſubdepreſſum, oblongum, ſubcordatum, ſupra medio ſulco longitudinali, ſubtus lamella oblonga fouea cincta. Inter hanc et baſin roſtri *papilla*, et in poſtica parte inter ouaria *papillula.*

ROSTRVM e medio corporis curuatum apice fiſſo, vbi os animalis.

OVARIA teretia, incraſſata, corporis longitudine.

In branchiis Gadorum *Callariae*, *Morhuae* et *Barbati* et in pinnis *Aeglefini*, STRÖM. *Söndm. I. p.* 167. *t.* 1. *f.* 7, 8. aliam ab hac diuerſam ſiſtit, eamque poſtea branchiis et fauci *Callariae* adhaerentem reperi, *Lernaeamque aduncam corpore ouato, cornu roſtri retrorſum deſcendente* dixi.

Fig. 2. prior Lernaeam a dorſo, poſterior a ventre ſpectatam naturali magnitudine ſiſtit.

LER-

LERNAEA GOBINA. 39

LERNAEA GOBINA.

LERNAEA corpore rhomboidali, brachiis duobus anticis totidemque poſticis nodoſis, cornibus binis arietinis. *Zool. D. pr.* 2747.

Dan. Sand-Ulkens Gielle-Orm.

CORPVS depreſſum, ſubquadratum, antice in caput productum; ex hoc vtrinque erigitur *cornu* introrſum arcuatum, angulis corporis anticis extrorſum et ſurſum oblique porriguntur *brachia* duo diuaricata; poſtice, vbi corpus latius eſt, infra angulos dependent organa brachiis ſimillima, at introrſum diuaricata et conniuentia, quae ex ſitu pedes diceres, at alium vſum habere videntur; vtraque in diuaricatione nodoſa ſunt. Inter pedes a poſtica corporis parte bina *filamenta* ſpiralia, apice acuta, (forte ouaria) in corporis longitudinem protenſa ſunt.

OS in capite ſubtus, trifidum in medio marginis poſtici tuberculum fiſſum, vbi anus; in quibusdam pellucet *inteſtinum* ab ore ad anum deductum.

COLOR corporis albo-coeruleus, ouariorum vero candidus eſt.

In branchiis parui piſcis, quem Groenlandi *Itekiudlek* nominant, ac Cottus *Gobio* eſſe videtur.

Fig. 3. Delineatio prior *Gobinam* pronam, poſterior ſupinam naturali magnitudine profert.

LERNAEA RADIATA.

LERNAEA corpore quadrato depreſſo, brachiis utrinque tribus, cornibus quatuor rectis. *Zool. D. pr.* 2748.

Dan. Berg-Lakens Gielle-Orm.

CAPVT orbiculare, tuberculis minimis obſitum, *corniculis* binis vtrinque, inferioribus longioribus pendulis, apice vero fiſſura oris, cum *palpis* binis introrſum curuatis. COLLVM breue.

CORPVS varie depreſſum et conuexum, poſtice craſſiuſculum; ſupra in ipſo collo lamella rotundata, deinde alia lunata, ac in dorſo duabus gibboſis ornatum; latera tribus paribus brachiorum ſeu organorum proſtantium inſtruuntur; horum antica conica ſunt ſitu paene horizontali, media ſub ventrem incuruata, poſtica maiora diuaricata. Subtus inter antica *papillae* duae, et infra in collo duae minores.

OVARIA corpore longiora, incraſſata; inter haec in poſtica corporis parte anus eſt; in hunc et per totum corpus ad finem capitis acicula immitti poterat.

Partes omnes conuexae duriuſculae lacteique coloris; depreſſae vero molles et griſeae ſunt.

In Coryphaena *rupeſtri Zool. D. pr.* 363, quam Groenlandi *Ingmingoak* vocant, at non in branchiis, ſed prope easdem in ſinubus oris totum caput inuoluit, haud frequens.

Fig. 4. Prior Lernaeam a dorſo, poſterior a ventre oculis naturali magnitudine ſiſtit.

K 2 LER-

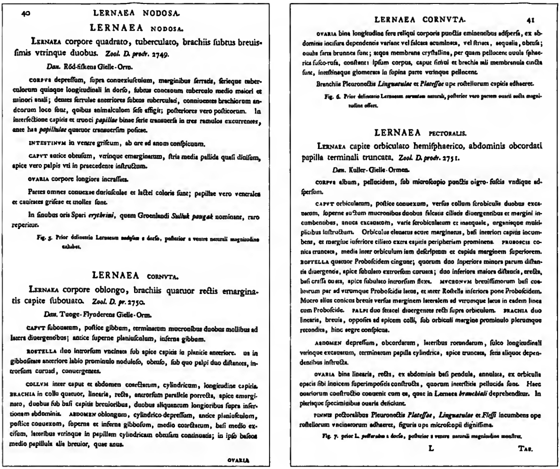
Müller's parasitic copepods from Zoologia Danica, *Plate 33, text (1788a).*

and Krøyer (1838, 1843, 1846, 1852) revealed the then-current species name. Some momentary confusion may come from finding Müller's "lower" fishes in the Amphibia, following Linnaeus. Finally, looking ahead to Müller's later publications, most of these lernaeid species were described in much more detail; where necessary in clarifying their current status, we will now examine these details.

Even without international rules, it is hard to imagine how anyone at any time could list a species and indicate that an older valid name for it was a junior synonym; yet this is what Müller, and many others, did—and sometimes still do. Müller stated that his first lernaeid, *Lernaea gadina,* was the same as Linnaeus's (and Strøm's) decade-old species *Lernaea branchialis.* He noted that it is called the "throat-ogre" ("throat-troll") or "fjord-cod's gill-worm." Perhaps he gave "gadina" pride of place because that was more specific to the host than was "branchialis." Such a practice was repeated many times over the years before nomenclatural procedures were well established. *Lernaea gadina,* from the gills of Greenland cod, is now considered by all to be synonymous with *Lernaeocera branchialis* (Linnaeus, 1767), the type species of the siphonostome genus *Lernaeocera* introduced by de Blainville in 1822.

The second species, *Lernaea salmonea,* the venerable "salmon-louse," was also indicated as a Linnaean species. It is, in fact, one of the original Linnaean species, now *Salmincola salmoneus* (Linnaeus, 1758), a lernaeopodid siphonostome. For this and the previous species, Müller included references to an eight-volume version of Valmont de Bomare's *Dictionnaire Raisonné Universel d'Histoire Naturelle.* Probably this was the 1767–1770 Copenhagen edition of this popular work (Agassiz 1848).

Müller (1776) said that the next "five species were discovered in Greenland by the Reverend Otto Fabri-



40 LERNAEA NODOSA.

LERNAEA NODOSA.

LERNAEA corpore quadrato, tuberculato, brachiis ſubtus breuiſſimis vtrinque duobus. *Zool. D. prodr.* 2749.

Dan. Röd-fiſkens Gielle-Orm.

CORPVS depreſſum, ſupra conuexiuſculum, marginibus ſerratis, ſerieque tuberculorum quinque longitudinali in dorſo, ſubtus concauum tuberculo medio maiori et minori anali; dentes ſerrulae anteriores ſubtus tuberculati, conniuentes brachiorum anticorum loco ſunt, quibus animalculum ſeſe affigit; poſteriores vero poſticorum. In interſectione capitis et trunci *papillae* binae ſerie tranſuerſa in tres ramulos excurrentes, ante has *papillulae* quatuor tranſuerſim poſitae.

INTESTINVM in ventre griſeum, ab ore ad anum conſpicuum.

CAPVT antice obtuſum, vtrinque emarginatum, ſtria media pallida quaſi diuiſum, apice vero palpis vti in praecedente inſtructum.

OVARIA corpore longiora incraſſata.

Partes omnes conuexae duriuſculae et lactei coloris ſunt; papillae vero ventrales et cauitates griſeae et molles ſunt.

In ſinubus oris Spari *erythrini*, quem Groenlandi *Sulluk paugak* nominant, raro reperitur.

Fig. 5. Prior delineatio Lernaeam *nodoſam* a dorſo, poſterior a ventre naturali magnitudine exhibet.

LERNAEA CORNVTA.

LERNAEA corpore oblongo, brachiis quatuor rectis emarginatis capite ſubouato. *Zool. D. pr.* 2750.

Dan. Tunge-Flynderens Gielle-Orm.

CAPVT ſubouatum, poſtice gibbum, terminatum mucronibus duobus mollibus ad latera diuergentibus; antice ſuperne planiuſculum, inferne gibbum.

ROSTELLA duo introrſum vncinata ſub apice capitis in planitie anteriore. OS in gibboſitate anteriore labio prominulo noduloſo, obtuſo, ſub quo palpi duo diſtantes, introrſum curuati, conuergentes.

COLLVM inter caput et abdomen coarctatum, cylindricum, longitudine capitis. BRACHIA in collo quatuor, linearia, recta, antrorſum parallele porrecta, apice emarginato, duobus ſub baſi capitis breuioribus, duobus aliquantum longioribus ſupra inſertionem abdominis. ABDOMEN oblongum, cylindrico-depreſſum, antice planiuſculum, poſtice conuexum, ſuperne et inferne gibboſum, medio coarctatum, baſi medio exciſum, lateribus vtrinque in papillam cylindricam obtuſam continuatis; in ipſo baſeos medio papillula alia breuior, quae anus.

OVARIA

LERNAEA CORNVTA. 41

OVARIA bina longitudine fere reliqui corporis punctis eminentibus adſperſa, ex abdominis inciſura dependentia variant vel falcata acuminata, vel ſtriata, aequalia, obtuſa; ouula ſarta brunnea ſunt; atque membrana cryſtallina, per quam pellucent ouula ſphaerica fuſco-rufa, conſtant ipſum corpus, caput ſimul et brachia tali membranula cincta ſunt, inteſtinaque glomerata in ſupina parte vtrinque pellucent.

Branchiis Pleuronectis *Linguatulae* et *Plateſſae* ope roſtellorum capitis adhaeret.

Fig. 6. Prior delineatio Lernaeam *cornutam* naturali, poſterior vero partem ouarii aucta magnitudine offert.

LERNAEA PECTORALIS.

LERNAEA capite orbiculato hemiſphaerico, abdominis obcordati papilla terminali truncata. *Zool. D. prodr.* 2751.

Dan. Kuller-Gielle-Ormen.

CORPVS album, pellucidum, ſub microſcopio punctis nigro-fuſcis vndique adſperſum.

CAPVT orbiculatum, poſtice conuexum, verſus collum ſcrobiculis duobus excauatum, ſuperne auctum mucronibus duobus falcatis ciliatis diuergentibus et margini incumbentibus, antice excauatum, varie ſcrobiculatum et inaequale, organisque multiplicibus inſtructum. Orbiculus eleuatus acute marginatus, baſi interiori capitis incumbens, et margine inferiore ciliato extra capitis peripheriam prominens. PROBOSCIS conica truncata, media inter orbiculum iam deſcriptum et capitis marginem ſuperiorem. ROSTELLA quatuor Proboſcidem cingunt; quorum duo ſuperiora minora parum diſtantia diuergentia, apice ſubulato extrorſum curuata; duo inferiora maiora diſtantia, erecta, baſi craſſa ouata, apice ſubulato introrſum flexa. MVCRONVM breuiſſimorum baſi coalitorum par ad vtrumque Proboſcidis latus, et inter Roſtella inferiora pone Proboſcidem. Mucro alius conicus breuis verſus marginem lateralem ad vtrumque latus in eadem linea cum Proboſcide. PALPI duo ſetacei diuergentes recti ſupra orbiculum. BRACHIA duo linearia, breuia, oppoſita ad apicem colli, ſub orbiculi margine prominulo plerumque recondita, hinc aegre conſpicua.

ABDOMEN depreſſum, obcordatum, lateribus rotundatum, ſulco longitudinali vtrinque excauatum, terminatum papilla cylindrica, apice truncata, ſetis aliquot dependentibus inſtructa.

OVARIA bina linearia, recta, ex abdominis baſi pendula, annulata, ex orbiculis opacis ſibi inuicem ſuperimpoſitis conſtructa, quorum interſtitia pellucida ſunt. Haec ouariorum conſtructio conuenit cum ea, quae in Lernaea *branchiali* deprehenditur. In plerisque ſpeciminibus ouaria deficiunt.

PINNIS pectoralibus Pleuronectis *Plateſſae*, *Linguatulae* et *Fleſſi* incumbens ope roſtellorum vncinatorum adhaeret, figuris ope microſcopii digniſſima.

Fig. 7. prior L. *pectoralem* a dorſo, poſterior a ventre naturali magnitudine monſtrat.

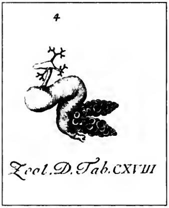
L TAB.

Müller's parasitic copepods from Zoologia Danica, *Plate 33, text, continued (1788a).*

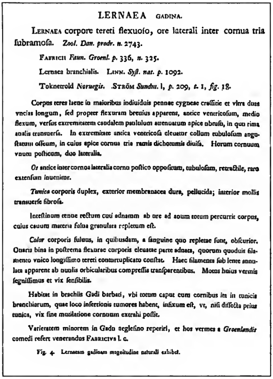
cius," and that none was known to Linnaeus. The first of these, *Lernaea cyclopterina,* was the "roe-bandit's gill-worm" from the fish *Cyclopterus lumpus.* Kabata (1979) indicated that Müller introduced this copepod without a description; that is, it was a *nomen nudum* and therefore has no status. In that case, Kabata relied on Otto Fabricius's description, so that the species carries on as *Haemobaphes cyclopterina* (O. Fabricius, 1780), the type species of this pennellid siphonostome genus, proposed by Steenstrup and Lütken in 1861. However, Müller's (1776) characterization of *Lernaea cyclopterina,* with brief Latin description, was no more a *nomen nudum* than any of the adjacent species. Nevertheless, *L. cyclopterina* was the only newly named *Lernaea* species not described more fully in later Müller publications. Perhaps that is why this was considered a *nomen nudum.* There remains a claim that this species should be marked with Müller's name rather than Fabricius's, even though Müller probably intended otherwise.

The fourth species on Müller's lernaeid list, and the second attributed to Fabricius, was *Lernaea uncinata,* the "big-cod's gill-worm" from *Gadus morhua,* with reference to Strøm. This is now considered synonymous with *Clavella adunca* (Strøm, 1762), the type species of the lernaeopodid siphonostome genus *Clavella,* established by Oken in 1816 (Wilson 1917a, Kabata 1979).

Müller next described *Lernaea gobina,* the "sand-sailor's gill-worm," discovered by Otto Fabricius on Greenland *Cottus gobio.* This may not yet have settled to one noncontroversial name. Wilson (1917a) and Stephensen (1950) regarded this as *Diocus gobinus* (Müller, 1776), in the chondracanthid poecilostome genus *Diocus* Krøyer, 1863. Kabata (1979), however, believed *L. gobina* to be a synonym of *Lernaeocera branchialis* (Linnaeus, 1767) and therefore identical to the first species on Müller's lernaeid list. A measure of the difficulty working with descriptions of convergently similar adult forms can be imagined by this example, since these two alternatives are



Müller's Lernaea gadina *from* Zoologia Danica, *Plate 118, with text (1789).*



LERNAEA GADINA.

LERNAEA corpore tereti flexuoſo, ore laterali inter cornua tria ſubramoſa. *Zool. Dan. prodr. n.* 2743.

FABRICII *Faun. Groenl. p.* 336, *n.* 325.

Lernaea branchialis. LINN. *Syſt. nat. p.* 1092.

Toknetrold *Norvegis.* STRÖM *Sundm.* I, *p.* 209, *t.* 1, *fig.* 18.

Corpus teres laeue in maioribus indiuiduis pennae cygneae craſſitie et vltra duas vncias longum, ſed propter flexuram breuius apparens, antice ventricoſum, medio flexum, verſus extremitatem caudalem paululum attenuatum apice obtuſo, in quo rima analis transuerſa. In extremitate antica ventricoſa eleuatur collum tubuloſum anguſtatum oſſeum, in cuius apice cornua tria ramis dichotomis diuiſa. Horum cornuum vnum poſticum, duo lateralia.

Os antice inter cornua lateralia cornu poſtico oppoſitum, tubuloſum, retractile, raro extenſum inuenitur.

Tunica corporis duplex, exterior membranacea dura, pellucida; interior mollis transuerſe fibroſa.

Inteſtinum tenue rectum cui adnatum ab ore ad anum totum percurrit corpus, cuius cauum materia fulua granulata repletum eſt.

Color corporis fuluus, in quibusdam, a ſanguine quo repletae ſunt, obſcurior. Ouaria bina in poſtrema flexurae corporis eleuatae parte adnata, quorum quoduis filamento vnico longiſſimo tereti contortuplicato conſtat. Haec filamenta ſub lente annulata apparent ab anulis orbicularibus compreſſis tranſparentibus. Motus huius vermis ſegniſſimus et vix ſenſibilis.

Habitat in brachiis Gadi barbati, vbi totum caput cum cornibus ita in tunicis branchiarum, quae loco inſertionis tumores habent, infixum eſt, vt, niſi diſſecta prius tunica, vix ſine mutilatione cornuum extrahi poſſit.

Varietatem minorem in Gado aeglefino reperiri, et hos vermes a *Groenlandis* comedi refert venerandus FABRICIVS l. c.

Fig. 4. Lernaeam gadinam magnitudine naturali exhibet.

from different copepod orders. Kabata does not indicate that *Cottus* species are among the definitive hosts of *L. branchialis.* Giving weight to the host species, as Wilson did, a third possibility may be sought in a species like *Achtheres percarum* von Nordmann, 1832, another lernaeopodid siphonostome.

Another discovery attributed to Otto Fabricius was *Lernaea radiata,* the "berg-salmon's gill-worm" from a Greenland *Coryphaena* species. This was equated by Wilson (1917a) and Stephensen (1950) to the chondracanthid poecilostome *Chondracanthus radiatus* (Müller, 1776), in the genus initiated by Delaroche in 1811. There are not many records of copepod parasites, other than *Caligus* species, on *Coryphaena* species (see Kabata 1979). Looking primarily at the host species for clues to its identity, Müller's "berg-salmon's gill-worm" might also be in the siphonostome genus *Pseudocycnus* Heller, 1865.

The last Fabricius-labeled lernaeid, and the seventh on Müller's list, is *Lernaea nodosa,* the "red-fish's gill-worm" from *Perca norvegica.* According to Stephensen (1950) and Kabata (1979), this is now *Chondracanthus nodosus* (Müller, 1776).

Unfortunately for O. Fabricius, who must have shown Müller a draft of *Fauna Groenlandica,* the Code has long dictated that species names be ascribed to the first author defining them in publication. In these last five cases, they would be ascribed to Müller. It is clear, however, that Müller was not trying to obtain credit for something he did not do. It is possible that there are earlier descriptions among O. Fabricius's obscure publications, but they were not referenced by Müller, nor have they extended into the usual copepod literature.

At this point in the narrative, the two following species, *Lernaea cornuta* and *L. pectoralis,* are phantoms. Müller (1776) says that they were "both discovered by the renowned Zoega." Johan Zoega (1742–1788), a Danish entomologist and, like his friend J. C. Fabricius, another Linnaeus student, is a spirit flitting in and out of our copepod history (Dahl 1941). Zoega may have described some species in manuscript; however, I have been unable to find a published copepod paper by him. It is known that he helped make collections, including copepods, that could be the source of Müller's reference. Until a Zoega publication comes to light, these two lernaeids belong to Müller.

Following this necessity, and according to Stephensen (1950) and Kabata (1979), *Lernaea cornuta* is now *Acanthochondria cornuta* (Müller, 1776). The genus was first defined by Oakley in 1927 as part of the chondracanthid poecilostomes. Müller (1788a) added that this species, the "tongue-flounder's gill-worm," had been taken from *Pleuronectes solea.*

Likewise, *Lernaea pectoralis* remains a Müller species, now in a genus defined by Nordmann in 1832, *Lepeophtheirus pectoralis* (Müller, 1776). Stephensen (1950) and Kabata (1979) register this synonymy among the caligid siphonostomes. Müller (1788a) added that this species, the "haddock's gill-worm," had been taken from *Gadus aeglefinus.*

Müller's next, and tenth, lernaeid is "*Lernaea* corpore cylindraceo," the lernaeid with a cylindrical body. Without a proper binomial, it is without status. In contrast to the other species (except for *L. cyclopterina*), Müller never returned to this. He said that it was found in cod intestines, so it may not have been a "lernaeid" at all but a (true) parasitic worm.

Müller's last lernaeid, *L. clavata,* which he described as "close to *L. uncinata*," was believed by Wilson (1917a) and Stephensen (1950) to be a species of *Peniculus* von Nordmann, 1832, *P. clavatus* (Müller, 1776). This species is now among the pennellid siphonostomes. Kabata (1979) made it another synonym of *Clavella adunca* (Strøm, 1762). However, Müller (1788a) added much more to his first description. The newly indicated host species, *Perca norvegica,* is more in keeping with the pennellid, which his rather good drawing shows it to be.

The vicissitudes of taxonomy, and the revelation of additional characters, have left none of the Müller lernaeids in the genus *Lernaea,* nor even in its order Cyclopoida. Of the eleven species, one without a proper name was not valid, two were acknowledged by Müller to be Linnaean species, one is now believed to be a synonym of a Strøm species, and one is (erroneously?) credited to Otto Fabricius at a later date, while the remaining six species retain Müller's authorship. Of the ten valid species, six are siphonostomes (from four families) and four are poecilostomes (from one family).

Zoologia Danica

By 1777, when the printing began on the *Zoologia Danica* plates, Müller, to save money, suggested that the text be only in Latin and German, since the Danish naturalists could read both. The government responded by saying that if any text was dispensed with, it would not be Danish! Therefore, to begin with, *Zoologia Danica* was published in all three languages. A bit of money was saved by issuing the first two Latin texts in a smaller format; Müller also felt this would be handier for those likely to use it. Each of the four parts had forty plates. The complete texts contain brief diagnoses, short lists of synonyms, and localities. Because there were so many text versions (within each part, they are essentially equivalent), a dated list is a helpful guide; note that Part Two began before certain versions of Part One were published:

Part One

(1777)	plates, with preliminary Danish text; 23 x 37 cm
(1777)	plates, with preliminary Latin text
(1779)	complete Latin text, small format
(1781)	complete Danish text
(1783)	complete German text
(1788)	plates and Latin text in original format

Part Two

(1780)	plates, with preliminary Danish text
(1780)	plates, with preliminary Latin text
(1784)	complete Latin text, small format
(1788)	plates and Latin text in original format

Part Three

(1789)	plates and Latin text in original format

Part Four

(1806)	plates and Latin text in original format.

The 1788–1806 version is the publication examined here.[1]

To produce *Zoologia Danica* at the same scientific and artistic level as *Flora Danica,* Müller paid special attention to the original illustrations and their engraving. He imported a noted German engraver, but the bulk of that work was ultimately done by Müller's younger brother, Christian Friderich Müller (1744–1814). C. F. Müller had a decided aptitude for this work, and some of his schooling in it was supported by the ever-generous Schulin family. C. F. Müller also was an enthusiastic participant in the field work. For forty years, he was connected with Denmark's finest botanical and zoological books. In the end, it was C. F. Müller who brought what completion there was to be to his brother's great dream of cataloging the Danish fauna (Anker 1950).

In the first part of *Zoologia Danica,* almost all the described animals were from Norway. Except for one fish, all were invertebrates and included protozoans, sponges, coelenterates, flatworms, nematodes, annelids, mollusks, and echinoderms. This pattern was followed fairly closely in the other parts. The text for all species is in the order of the plates, which are in no order whatsoever. In the second part, the only mammal, a lemming, might startle the invertebrate zoologist; it also is a stark reminder that the work was never finished.

Müller sent the first part of *Zoologia Danica,* essentially just the plates, to von Haller in April 1777 (presumably the version with the preliminary Latin explanations). The king, however, had to wait until May for his copy, probably with the Danish explanations.

By February 1778 Linnaeus was gone, and his place as a leading naturalist was taken by Müller.

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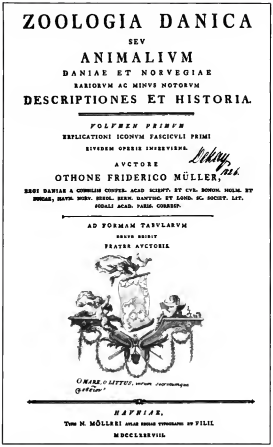
[1] It was a thrill to find this time-honored work in a Copenhagen bookstore in 1980. There was an initial discussion with the bookstore proprietor about it not leaving Denmark. Having already noticed a previous owner's signature ("DeKay, 1826"), I said it was just going back to the United States. The proprietor then admitted that he had purchased it at auction in San Francisco. James E. DeKay had also inscribed "Four volumes in one—(perfect) JED"—so he was a bibliophile after my own heart, as well as a copepodologist. We will meet him again, in 1822.



ZOOLOGIA DANICA
SEV
ANIMALIVM
DANIAE ET NORVEGIAE
RARIORVM AC MINVS NOTORVM
DESCRIPTIONES ET HISTORIA.

VOLVMEN PRIMVM
EXPLICATIONI ICONVM FASCICVLI PRIMI
EIVSDEM OPERIS INSERVIENS.
AVCTORE
OTHONE FRIDERICO MÜLLER,
REGI DANIAE A CONSILIIS CONFER. ACAD SCIENT. ET CVR. BONON. HOLM. ET [illegible], HAVN. NORV. BEROL. BERN. DANTISC. ET LOND. SC. SOCIET. LIT. SODALI ACAD. PARIS. CORRESP.

AD FORMAM TABVLARVM
DENVO EDIDIT
FRATER AVCTORIS.

O MARE, O LITTUS, verum secretumque [illegible]!

HAVNIAE,
Typis N. MÖLLERI AVLAE REGIAE TYPOGRAPHI ET FILII.
MDCCLXXXVIII.

DeKay

Title page of Müller's Zoologia Danica, *Part 1 (1788a). This particular copy of the Latin version in the original format was owned by James E. DeKay, an American physician and copepodologist.*

In the preface to *Zoologia Danica,* Müller said that he published each set of forty plates as soon as they were ready, without waiting for the text, to make the most of life's brief and uncertain span. Indeed, overworked and in increasingly poor health, Müller despaired of ever completing more—prophetically so, for Müller's brief span ended suddenly on 26 December 1784. Some of his best work was yet to appear, but his death nearly ended the *Zoologia Danica.*

Müller bequeathed his extensive library to the University of Copenhagen, save for the manuscripts necessary to continue the unfinished publications. Müller's long-supportive widow died in 1787.

The *Zoologia Danica* was given a wide and favorable reception. Abroad, friend and admirer Johann Hermann said that the work was unequaled, but he deplored the small circulation. There was lavish praise printed in journals, and posterity has upheld these assessments. Otto Fabricius, "Müller's zoological protégé" and the Danish zoologist most closely associated with Müller, completed some of Müller's manuscripts (Anker 1950).

Extraordinary steps were taken to continue the Danish fauna. Publication of *Zoologia Danica* resumed after several years, due to the efforts of Müller's widow and brother; both had the required connections, one had the necessary money, and the other provided the artistic talent. The first task was to complete the third part; this needed a working zoologist. The choice was Peter Christian Abildgaard (1740–1801) to be mentioned in an independent copepod context (see Chapter 8). Abildgaard is remembered as the founder, in 1773, of the Danish Veterinary School. His early interests in natural history were encouraged by his father, especially when they included practical subjects like chemistry and drawing. Abildgaard eventually, in 1768, received a Doctor of Medicine degree from the Veterinary School in Lyon. Even as a "proper" physician, Abildgaard preferred his veterinary research, especially that involving parasites of all kinds. Abildgaard published an important anatomical study showing that hagfish were not Vermes, as Müller and his predecessors had called them, but were in fact fish. Abildgaard had a significant role in the founding (in 1789) of the Natural History Society of Copenhagen. He had known Müller and had contributed to the large zoological collections, so Abildgaard's choice as successor-publisher was doubly ordained.

The last two parts of *Zoologia Danica* contained fewer references to the *Prodromus,* since there were now many new species as well as new references to Otto Fabricius's *Fauna Groenlandica* of 1780. Since state support had ended, there would only be the Latin versions of the remaining parts. C. F. Müller also decided to republish the first two parts in the original format, in Latin, to ensure that there would be compatible copies with the remaining installments. In these, there were slight changes in text and none in the plates. The third part (1789) included a few more animals from Denmark proper, especially from the Baltic and the Sound, than did the earlier parts. There was also the first description of the common freshwater annelid, *Tubifex tubifex,* although the genus name was given later by Lamarck. Also included were specimens collected in

Norway by Müller's friend, the Norwegian priest Hans Strøm. The title page mentioned Abildgaard's contributions to the descriptions.

After 1789, C. F. Müller and Abildgaard continued to collect new material for the fauna's fourth part. They were heartened by a little state support for the plates, but the labor went slowly. Abildgaard made collections in Helgoland in the North Sea, a rocky island that was Danish until 1807. He was working on this material when he died in 1801.

Abildgaard's death necessitated the recruitment of still another scientist, in this case Martin Vahl (1749–1804). Vahl was an eminent botanist as well as an entomologist, and he was also a student of Linnaeus. Like Abildgaard, Vahl was a charter member of the Natural History Society of Copenhagen. He had taken over the *Flora Danica* when Müller died, and now, perhaps fittingly, he was to take up its sister publication, the Danish fauna. At this time (1801), Vahl was made Professor of Botany at the University of Copenhagen. Vahl combined the collecting for both the flora and fauna, adding material from northern Norway. Unfortunately, as if the enterprise was cursed, Vahl also died with the fourth part of the fauna unpublished.

This called for a third replacement. A careful but not renowned zoologist, Johan (Hans) Severin Holten (1770–1805), who will soon be mentioned beside a separate copepod contribution, was the next choice. He was a nephew of Abildgaard (Henriksen 1923). Although not backed by a string of publications or academic achievements, Holten had useful influence in his capacity as tutor to Crown Prince Christian VIII, who later became king. Holten was able to add a few specimens, but mainly he only arranged what Müller, Abildgaard, and Vahl had left. Then, adding support to my curse theory, Holten died in 1805.

Probably in desperation, C. F. Müller this time turned to two zoologists, the Norwegian Jens Rathke (1769–1855) and the Dane Niels Tonder Lund (1749–1809). Tonder Lund, an entomologist, was a friend of Vahl and was also prominent in the Natural History Society of Copenhagen. He finished the compilation for the fourth part and turned it over to Rathke. Rathke had been a pupil of Martin Vahl in the Natural History Society of Copenhagen. In 1810, he was appointed Professor of Natural History at the University of Copenhagen; in 1813, he transferred to the new University of Christiania. When Norway separated from Denmark the following year, Rathke stayed in Norway. By that time, Rathke had already published the last part of Müller's *Zoologia Danica* (1806), which showed the supplemental authorship of Abildgaard, Holten, Vahl, and Rathke. In the world at large, this event had been much overshadowed by the turmoil in Napoleonic Europe. But in the zoological world, where the great work was understood, the now-concluded fauna was acknowledged and appreciated. Touching on things that might have been, the fourth part included several plates of fish and birds.

Jens Rathke (1799) published some observations on a variety of marine invertebrates, including a species of "Lernaea." This copepod contribution will be considered near the end of Chapter 8.

* * *

C. F. Müller died in that fateful year of 1814, leaving no one from the time of the great fauna's inspiration. Like so many other comprehensive publications, a normal life span (or more) was not sufficient, and when those who shared the concept passed on, no one was left to see it through. *Zoologia Danica* remains a truncated monument to Denmark's eighteenth-century golden age of natural history.

I have presented a detailed publication history of *Zoologia Danica* for two reasons: first, for its own importance in the history of marine science, especially of northern countries, and the part it played in the early recognition of copepods; and second, because most of the participants and contributors also made separate contributions to our knowledge of copepods. This illuminates the often convoluted but still strong and numerous bonds between workers.

In the *Zoologia Danica,* of special interest to us are seven species of parasitic copepods taken from the gills or fins of fishes; Müller (1788a) included expanded text descriptions and illustrations (on his Plate 33). Müller said that "*Lernaea* is especially astonishing for its diverse composition." In the *Prodromus,* Müller listed these and four other "species" and placed them under the worms and within the mollusks; they were the "Gaellormer," or "gill-worms." In the third part of *Zoologia Danica,* Müller (1789) described and illustrated (on his Plate 98) an eighth species, *Lernaea gadina.* The present status of each of these species was indicated above, in the discussion of the *Prodromus.* No other copepods appeared in *Zoologia Danica,* but many were described in the posthumous milestone, *Entomostraca* (Müller 1785).

Entomostraca

For copepods, Müller's (1785) most significant work appeared in the year following his death: *Entomostraca,* "or testaceous insects, which are found in the waters of Denmark and Norway, described and illustrated." The species and genera not yet dealt with in the Danish fauna were described there.

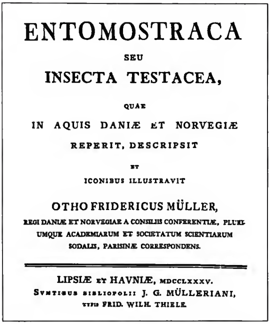
Müller dedicated this book also to the young Crown Prince, Frederick, telling him that "these uniquely structured animals were recently discovered in Our Native Land."

The *Entomostraca* in truth was a product of the Müller brothers. O. F. Müller studied each specimen with magnifying glasses and made notes; then C. F. Müller did the same. Afterward, they compared observations. Once they had agreed on the details, C. F. Müller made the drawings (Anker 1950).

Müller proposed the new term "Entomostraca" (from Greek, the insects with a shell), out of the Linnaean Monoculi, as an order of the Class Insecta. Entomostraca are divided into two sections—Monoculi and Binoculi—depending on whether they have one or two eyes. The Monoculi are further subdivided into Univalves, Bivalves, and Crustacei, depending on shell-covering form. The Binoculi are only univalve or bivalve. Altogether, Müller described eleven genera, four of which are for copepods.

The genera *Nauplius* (with two species) and *Amymone* (with six species) were mentioned in the *Prodromus;* these are all early (immature) stages of copepods, and neither genus has taxonomic validity. Both were univalve Monoculi. Müller cited Lange (1756) and believed that Lange's copepod was *Cyclops quadricornis,* but Müller failed to relate Lange's newly hatched forms to the later ill-conceived *Nauplius* and *Amymone.*

In the crustaceous Monoculi, Müller further described his (1776) genus, *Cyclops,* with thirteen species. At this momentous point, copepods were given much more attention and thereby became more scientifically "respectable" than ever before. Of the thirteen *Cyclops* species, eight had been mentioned in the *Prodromus*: *C. minutus, C. lacinulatus, C. caeruleus, C. claviger, C. chelifer, C. brevicornis, C. longicornis* (as *finmarchicus*), and *C. quadricornis.* All but one (*C. brevicornis*) of the *Cyclops* species are illustrated, and



ENTOMOSTRACA

SEU

INSECTA TESTACEA,

QUAE

IN AQUIS DANIÆ ET NORVEGIÆ

REPERIT, DESCRIPSIT

ET

ICONIBUS ILLUSTRAVIT

OTHO FRIDERICUS MÜLLER,

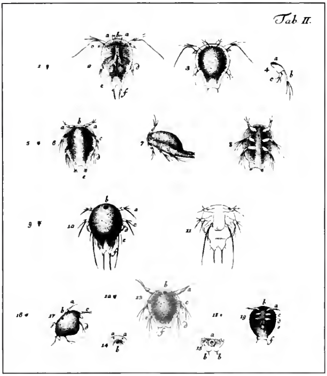
REGI DANIÆ ET NORVEGIAE A CONSILIIS CONFERENTIÆ, PLURIUMQUE ACADEMIARUM ET SOCIETATUM SCIENTIARUM SODALIS, PARISINÆ CORRESPONDENS.

LIPSIÆ ET HAVNIÆ, MDCCLXXXV.

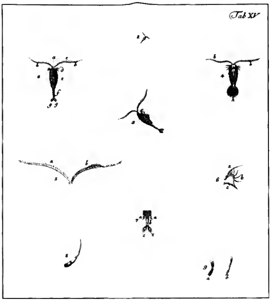
SVMTIBUS BIBLIOPOLII J. G. MÜLLERIANI,

TYPIS FRID. WILH. THIELE.

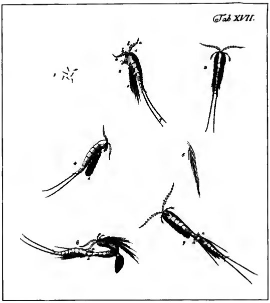
Title page of Müller's posthumous Entomostraca *(1785).*



Amymone *species, like* Nauplius, *an early developmental stage and not, as Müller believed, the adult animal. From Müller (1785).*



Cyclops caeruleus. *From Müller (1785).*



Cyclops minutus. *From Müller (1785).*

all received expanded text descriptions. The five new *Cyclops* species were *C. rubens, C. crassicornis, C. curticornis, C. captivus,* and *C. minuticornis.* Müller attempted a standard format, giving the length of each species in Danish lines (2.18 mm) (Damkaer and Damkaer 1979) and describing body, abdomen, head, eyes, genital segment, and caudal setae. Other information included where they were found and the time of breeding for several species. Illustrations indicated natural size, magnified size, and magnified appendages. The latter included "antennae," "palp" (now second antennae), eyes, feet, caudal setae, and often special parts such as genital segments. Besides details appearing for the first time, the arrangement of so many species side by side was a tremendous technical advance.

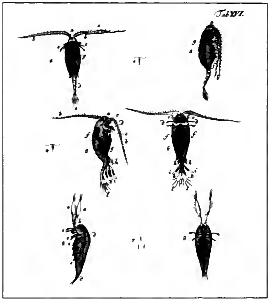
Still, like other early species, Müller's species are not all clearly defined against the large number of subsequent species descriptions. Very likely Müller, as others, had more than one species under observation when he believed he was only looking at a single one. Schmeil (1892) attempted to equate Müller's freshwater *Cyclops* species to well-defined species, essentially saying that because of major uncertainties, this was the best he could do:

1. *Cyclops minutus* = *Canthocamptus staphylinus* (Jurine, 1820), in a harpacticoid copepod genus proposed by Westwood in 1836. Lang (1948) thought that Müller's species was unidentifiable.
2. *Cyclops caeruleus, C. rubens,* and *C. claviger* were mixed with *Diaptomus castor* (Jurine, 1820) and *D. caeruleus* (Fischer, 1853); *C. claviger* was an immature stage. (I do not know why *D. caeruleus* bears Fischer's name and not Müller's.) These are clearly calanoid copepods; the genus *Diaptomus* was proposed by Westwood in 1836 (Schmeil 1896).
3. *Cyclops lacinulatus* = *Eurytemora lacinulata* (Fischer, 1853). (Again, perhaps this should be Müller's species, not Fischer's.)
4. *Cyclops quadricornis* is perhaps *Cyclops strenuus* Fischer, 1851, but it is more likely a composite species.
5. *Cyclops crassicornis,* also an immature stage, could be *Cyclops fimbriatus* Fischer, 1853.

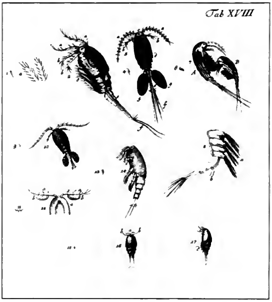
Müller had some interesting observations about his *Cyclops lacinulatus.* He derived the species name from the laciniae, or lappets, on the uropod; we now know these lappets to be spermatophores. Müller described them physically, saying there were both opaque and translucent types. He mentioned them several times in reference to the breeding process, but their true purpose did not occur to him. Mostly he thought the lappets were merely a hindrance.

Müller reported the remaining six *Cyclops* species from marine habitats and therefore beyond Schmeil's review. *Cyclops captivus* was found inside a mussel; from Müller's illustration, it appears to be a commensal cyclopoid copepod, the first of such noted.

For reasons not now known, Müller renamed



Cyclops rubens *(Figs. 1–3),* **C. lacinulatus** *(Figs. 4–6), and* **C. claviger** *(Figs. 7–9). From Müller (1785).*



Cyclops quadricornis *(Figs. 1–14) and* **C. crassicornis** *(Figs. 15–17). From Müller (1785).*

Gunnerus's *Cyclops (Monoculus) finmarchicus* as *Cyclops longicornis,* a different species, causing a near-century of great confusion. Müller (1785) stated that his species had "been found by chance by the immortal Gunnerus in Finmark's Sea and later in Drobak Sound in the stomach of *Clupea.*" From Müller's illustrations, Giesbrecht (1892) stated that *Cyclops longicornis* is *Temora longicornis* (Müller, 1785) in a calanoid copepod genus proposed by Baird in 1850.[2]

The last four *Cyclops* species are marine harpacticoid copepods, and Lang (1948) had opinions about their status. Lang said that *Cyclops minuticornis* and *C. curticornis* could not now be identified. Müller's drawings have many characteristics of immature forms, but the specimen of the former carries an egg sac.

Lang believed that *Cyclops chelifer* was the species now known as *Harpacticus chelifer* (Müller, 1776), in a genus proposed by Milne Edwards in 1840. He likewise believed that the remaining species, *Cyclops brevicornis,* was *Tigriopus brevicornis* (Müller, 1776), in a genus proposed by Norman in 1868.

It is curious now to note after more than two hundred years that Müller's (1776) first species under his new genus *Cyclops* was a harpacticoid copepod. In recent decades, this would have ensured that the type species of that genus would be a harpacticoid, not, as long usage has made it, the archetype freshwater cyclopoid copepod.

Returning to Müller's (1785) broad category Binoculus, there is one last copepod genus to consider: the new genus *Caligus.* Of these parasites, Müller said "it is the common opinion that it is the Caligi which force the salmon from the sea, up rivers toward the waterfalls." The Latin term "caligus" is sometimes interpreted as meaning blind, and the question has arisen as to why such an obvious two-eyed form would have led Müller to call it blind. The term "caligus" denotes being in fog, or mist. Müller cites Baster (see Chapter 6), who indicated that the eyes of this form are stained, or spotted, with small black flecks: "from these eyes, the caligid genus name is obtained." Thus, *Caligus* species are not blind, but merely see life unclearly through darkened eyes.

Müller (1785) described two species in the new genus *Caligus.* He said that the first, *Caligus curtus,* was the same species that he had called *Binoculus piscinus* in the *Prodromus,* and that had been found on cod and *Pleuronectes* by Strøm ("Torskeluus"), Herbst ("Flinderlaus"), and Baster (*Pediculus pleuronectis* and *P. aselli*). This species, *Caligus curtus* Müller, 1785, remains as the type of this caligid siphonostome genus (Kabata 1979).

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[2] I noted that Giesbrecht actually referred to Müller (1785) as "Müller (1792)," giving Frankfurt as the place of publication. Apparently there was a near-contemporary reprint of Müller's monograph, but I have not seen it; it is not cited in Agassiz (1853).

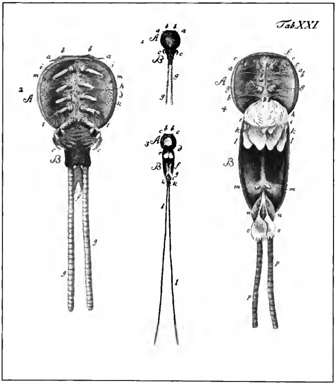
Müller said that his other species, *Caligus productus,* was the same as that called "Hemorlaus" by Herbst. Müller did not say where he found this, but Steenstrup and Lütken (1861) believed that Müller's examples were from the same Faroe Islands specimens that had been given to Herbst. The species is now *Dinemoura producta* (Müller, 1785), a shark parasite in the genus defined by Latreille in 1829 (Baird 1850, Kabata 1979). (There was another *Caligus productus,* described independently by Dana in 1852; these are not the same species.)

* * *

Looking back on Müller and his contributions, one might believe that he did not know much about copepods. But in Müller's day, no one knew more. His *Entomostraca* was a cardinal point in the progression of our learning about copepods.

For a generation after Müller, copepodology as a separate field marked time with greater and lesser men, who added only small bits of information before most of them disappeared. The remarkable exception to this was Jurine, who contributed insignificantly just before the turn of the century only to reappear as a copepodological comet in 1820.

Even though copepodology did not advance much during the post-Müller generation (see Chapter 8), huge strides were made in France in the classification of crustaceans in general (see Chapter 9). Thus, for a time, the center of crustacean knowledge moved away from northern Europe.



Caligus curtus *(Figs. 1–2) and* C. productus *(Figs. 3–4). From Müller (1785).*

8

A FORESIGHT OF NATURE

> In the case of very short or unimportant communications, a certain amount of discretionary power was indispensable. Our popular "Magazines" of Natural History teem with trifling notices, often anonymous, sometimes brief and indefinite, sometimes wordy and inflated, but which do not contain a single fact of scientific importance. To have recorded all such in our list would have added bulk but not value, and they have therefore been in general omitted.
>
> —H. E. Strickland, in Louis Agassiz, *Bibliographia Zoologiae et Geologiae*

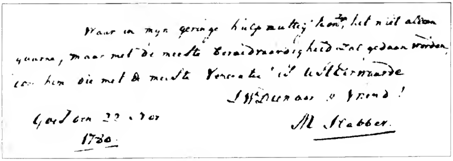
Although some authors had numerous copepod works published over several years, this was seldom the case before O. F. Müller. These authors are considered in the order of their earliest notable publication, necessitating some chronological overlap. Müller overshadowed everyone who worked on copepods during his productive time. Individually, there were only minor additions to copepod knowledge made by others until about 1800, although the total contribution is significant.

Martin Slabber

31 October 1740–30 April 1835

Martin Slabber, from 1769 to 1778, published in Haarlem (Holland) a descriptive eighteen-part series, "Natural-science diversions, or microscopic observations on water- and land-animals." Slabber illustrated the metamorphosis of barnacles, but this was quickly forgotten. He also indicated metamorphosis in decapods and gave the first sketches of a mysid and a chaetognath (Miall 1912). Another first was the illustration of the "sea-spark" (*zeevonk*), the "especially small and delicate" luminescent dinoflagellate now known as *Noctiluca* (see van Benthem Jutting 1970); this had been described but not illustrated by Baker (Cole 1926).

Signature of Martin Slabber (1740–1835). From van Benthem Jutting (1970).



Waar in myn geringe hulp nuttig kan, het niet alleen
gaarne, maar met de meeste bereidvaardigheid zal gedaan worden,
ten hem die met de meeste Veneratie is UEdelEerwaarde
[illegible] dienaar en Vriend!

Goes den 22 9ber
1780.

M Slabber.

In 1778, Slabber illustrated *"Oniscus lutosus,"* which Baird (1850) said was a good drawing of a species of *Caligus*, and which Wilson (1905) noted was not only right-side-up, but correctly showed the antennae and several other appendages. Other Slabber *Oniscus* species have been identified as isopods. Slabber described some "sea lice," which he called *Monoculi marini* and which later readers thought might be the copepod *Harpacticus chelifer* (Müller, 1776) (see van Benthem Jutting 1970). Agassiz (1854) listed four other papers by Slabber; from the titles, they appear to be supplements to the larger work.

Slabber was born in Middelburg, Zeeland, Netherlands, but as a young man he moved to the nearby town of Goes, where he was at times burgomaster as well as president of the Court of Justice. From his earliest years Slabber was interested in natural history, and during his leisure hours he collected and described North Sea organisms, especially the smallest forms as seen under his Cuff's microscope.

Slabber had no academic background, but he made the most of personal contacts with like-minded Zeelanders (*Zeeuwsch*), particularly Job Baster, as well as other Dutchmen, such as the insect anatomist Pierre Lyonet (1707–1789) and the ichthyologist Martinus Houttuyn (1720–1798), during visits to the principal natural history cabinets throughout the Netherlands. Baster brought Slabber into the Netherlands Academy of Sciences in 1767. Birds also attracted Slabber's eye, and he acquired a large cabinet of mounted specimens. In 1816, he published an essay on bird studies. King Willem I recognized Slabber's long service with a title and a pension in 1827. There is no known portrait of Slabber (van Benthem Jutting 1970).

Slabber was among the nonagenarians along with, up to this point, only Leeuwenhoek.

Charles De Geer

30 January 1720–7 March 1778

In spite of small notices in Holland, England, and elsewhere, most of the copepod activity at the end of the 1700s remained in Scandinavia. Charles (or Karl) De Geer was born in the Swedish province of Ostergotland into a family of wealthy merchants, who had long before come from Holland. He was educated in botany and physics at the University of Utrecht (Holland), and by modernizing the family foundry he added to his wealth. De Geer's riches allowed him to freely support his own new interests in insects, as well as community social and educational programs (Nordenskiold 1928). He lived near Uppsala and freely associated with Linnaeus, who acknowledged De Geer's influence in his own work (Winsor 1976a). Agassiz (1853) listed twenty-eight De Geer papers on insects.

Surprisingly, De Geer did not adopt the Linnaean method of nomenclature. Still, his many entomological works have so much pertaining to structures, behavior, and relationships that they are of lasting value.

De Geer, in his seventh and last volume of *Memoires pour servir a l'Histoire des Insectes* (1752–1778), published in Stockholm in 1778, "describes at considerable length, and figures with tolerable accuracy, the *Cyclops quadricornis*, and confirms many of Leeuwenhoek's statements respecting it, particularly the great difference between the young and the old animal" (Baird 1850). De Geer provided figures of different growth stages over about fifteen days. His findings were ignored by his immediate followers, who could not believe such disparate forms could be of one species, and a generation passed until this fundamental error was corrected by Ramdohr and Jurine.

Charles De Geer (1720–1778). From Bonnet (1945).

De Geer, like Geoffroy, thought that all monoculi are oviparous, but he added that since they carry their eggs until hatched, they could also be considered viviparous! He said that the Cyclopidae and all other monoculi feed on "animalcules." Both Leeuwenhoek and De Geer said that if deprived of that food, they would eat their own young.

Otto Fabricius

6 March 1744–20 May 1822

Otto Fabricius was one of the first to study Arctic marine animals, producing a monograph, the *Fauna Groenlandica* of 1780, that was alone in its field for decades (Wolff 1967). Otto Fabricius was sent as a missionary in 1768 to Denmark's Greenland colony of Frederikshab. There, on Greenland's southwest coast, he lived for five and a half years with the Inuits and observed the local animal world from his silent kayak. Evenings were spent by candlelight in native huts, with his hand lens and only book, Linnaeus's *Systema Naturae*, trying to make sense of his collections (Wolff 1979).

Fauna Groenlandica held the descriptions of nearly five hundred animals, a quarter of them new to sci-

Otto Fabricius (1744–1822). From Wolff (1979).

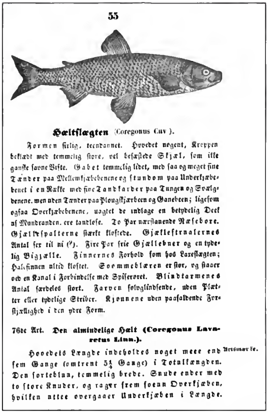
ence. It also contained much ecological information; for a very long time, O. Fabricius (1780) was the most-cited Danish zoological work (Wolff 1979). The *Fauna* included seven species of parasitic copepods, placed in the genus *Lernaea* in the chapter on worms. These had already been recorded and briefly described by Müller (1776) through his close association with Fabricius: *L. gadina, L. cyclopterina, L. salmonea, L. uncinata, L. gobina, L. radiata, and L. nodosa.* As outlined in the previous chapter, three were synonyms of Linnaeus or Strøm species, one only has been credited to Fabricius, and the other three are now considered Müller species.

Fabricius included no drawings of these species, but his Latin descriptions were detailed and therefore further supplemented Müller's descriptions.

Of the "marine insects," Fabricius recorded *Binoculus piscinus* (later believed to be Müller's *Caligus curtus*) and Müller's *Cyclops brevicornis* (later *Tigriopus brevicornis*).

Otto Fabricius (1794) described a "gill-worm" from the whitefish, *Coregonus lavaretus* Linnaeus. Fabricius called the new species *Lernaea lavareti.* We know now that lernaeids do not generally appear on gills, but *Ergasilus* species do, and Fabricius's species is likely *E. sieboldi* (see Wilson 1917a).

In addition to natural history commentaries, O. Fabricius, who was only distantly related to J. C. Fabricius, is well known for his important ethnographic and linguistic contributions (Wolff 1979). After the completion of *Fauna Groenlandica*, Fabricius became a Professor of Theology, but he continued his natural history studies in the surroundings of Copenhagen until his death. In 1820, he made the significant discovery of the surface cilia of planarians (flatworms). Otto Fabricius died a bishop, after a long and respected life (Jensen 1944, Wolff 1967).



55

Hæltſlægten (Coregonus Cuv.).

Formen ſirlig, teendannet. Hovedet nøgent, Kroppen beklædt med temmelig ſtore, vel beſæſtede Skjæl, ſom ikke ganſke ſavne Viſte. Gabet temmelig lidet, med faa og meget fine Tænder paa Mellemkjæbebenene og ſtundom paa Underkjæbebenet i en Række med fine Tandkarder paa Tungen og Svælgbenene, men uden Tænder paa Plougſkjærbeen og Ganebeen; ligeſom ogſaa Overkjæbebenene, uagtet de indtage en betydelig Deel af Mundranden, ere tandløſe. To Par nærſtaaende Næſebore. Gjælleſpalterne ſtærkt kløftede. Gjælleſtraalernes Antal ſex til ni (?). Fire Par frie Gjællebuer og en tydelig Biggjælle. Finnernes Forhold ſom hos Laxeſlægten; Halefinnen altid kløftet. Svømmeblæren er ſtor, og ſtaaer ved en Kanal i Forbindelſe med Spiſerøret. Blindtarmenes Antal ſærdeles ſtort. Farven ſølvglindſende, uden Pletter eller tydelige Striber. Kjønnene uden paafaldende Forſkjellighed i den ydre Form.

76de Art. **Den almindelige Hælt (Coregonus Lavaretus Linn.).**

Hovedets Længde indeholdes noget mere end fem Gange (omtrent 5¼ Gange) i Totallængden. Den ſorteblaa, temmelig brede. Snude ender med to ſtore Knuder, og rager frem foran Overkjæben, hvilken atter overgaaer Underkjæben i Længde. Artsmærke.

The fish Coregonus lavaretus *on which O. Fabricius found the parasitic copepod* "Lernaea lavareti." *From Krøyer (1846).*

Johann Friedrich Wilhelm Herbst

1 November 1743–5 November 1807

Johann Friedrich Wilhelm Herbst described two species of caligid. The first, in 1780, was called the "See-laus von Hemorfisch" (Vervoort 1986b). This was placed by Müller (1785) into his new genus *Caligus as Caligus productus,* although as the same species it is now in the genus *Dinemoura* Latreille, 1829 (see Baird 1850, Kabata 1979). Steenstrup and Lütken (1861) told us that Herbst obtained his specimens from Pastor Chemitz of Copenhagen, who had taken them from the tail of a Faroe

Islands "hemor fish . . . three ells long [about 2 m] and thick as a sack."[1] This, these authors indicate by way of comparing the common name from different Nordic localities, is the mackerel shark, *Lamna cornubica*. They also believed that Müller had obtained his specimens from the same lot.

A second paper (in 1782) described the "Flinder- oder Hellebluttenlaus," now *Caligus curtus* Müller, 1785. I have encountered little biographical information about Herbst; Agassiz (1853) listed twenty-eight Herbst publications during 1780–1806, mostly on insects but including a three-volume work on crustaceans (the portrait is from the first volume). The title page stated that Herbst was a preacher at the Berlin Marienkirche and a member of the Berlin Society of Friends of Natural History. Jourdan (1822a) noted that several Herbst publications contained numerous colored plates.

Hagen (1862) determined that Herbst "was born at Petershagen (Minden) [south of Bremen], where his father was a superintendent." Herbst had his early education in Berlin and afterward accepted a position as chaplain in a Prussian infantry regiment (Jourdan 1822a). He rose in ecclesiastical rank through several churches in Berlin, attaining the position of archdeacon. Hagen listed seventeen insect papers and added that Herbst's collections were deposited in the Berlin Museum. Lindroth (1973) said that Herbst was one of the first entomologists to specialize, in Herbst's case in beetles.

Johann Friedrich Wilhelm Herbst (1743–1807). From Herbst's 1790 **Versuch einer Naturgeschichte der Krabben und Krebse.** ***Courtesy of W. Vervoort, Leiden.***

Charles Cordiner

? 1746?–18 November 1794

The Reverend Charles Cordiner published a popular travel/educational book in 1780: *Antiquities and Scenery of the North of Scotland*. Baird (1850) said that Cordiner included a lernaeid, the same species as Linnaeus's *Lernaea salmonea*, from the gills of salmon in rivers.

Not much seems to have been recorded about this naturalist clergyman. According to Yonge (1972), Cordiner was the Episcopalian minister of St. Andrews Chapel at Banff from 1769. He was encouraged in his extracurricular studies after meeting Thomas Pennant (1726–1798), the well-traveled author of *British Zoology* (1766) and *History of Quadrupeds* (1781). In fact, Cordiner's 1780 book is based on a series of letters to Pennant. Cordiner published a second natural history travelogue, *Remarkable Ruins . . . and Natural History*, in 1788. This contained twenty-four sections with marine invertebrates illustrated and classified according to Linnaeus. Most of these were intertidal, apparently without copepods.

I am in good company when I, like Johnston (1847), admit to not having seen Cordiner's works, which must be rare.

Johann Conrad Eichhorn

6 February 1718–17 September 1790

The Prussian Johann Conrad Eichhorn, pastor of the Church of St. Catharine in Danzig, was the author of a popular book on the natural history of the small organisms found in freshwater ponds (Hagen 1863). Eichhorn's (1781) unassuming little book did not have scientific pretensions, but it was widely cited in what scientific literature there was immediately following that time. Its title translates as "Contribution to the natural history of the smallest water-animals, which cannot be seen with the naked eye, and which are found in the waters in and around Danzig." Many of Eichhorn's "water-animals" came from the Radunia, the branch of the Vistula's delta that passes through Danzig

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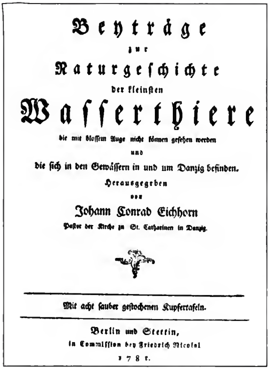
[1] Steenstrup used the Dutch and Flemish ell of about twenty-seven inches, rather than the English ell of forty-five inches (Muntz 1995). Like the anatomical basis of the foot, the archaic ell has its root in elbow and ulna.



Beyträge
zur
Naturgeſchichte
der kleinſten
Waſſerthiere
die mit bloſſem Auge nicht können geſehen werden
und
die ſich in den Gewäſſern in und um Danzig befinden.
Herausgegeben
von
Johann Conrad Eichhorn
Paſtor der Kirche zu St. Catharinen in Danzig.

Mit acht ſauber geſtochenen Kupfertafeln.

Berlin und Stettin,
in Commiſſion bey Friedrich Nicolai
1781.

Title page of Eichhorn's "Contributions to the Natural History of the Smallest Water-Animals" (1781).

(now Gdansk, Poland). According to Agassiz (1850), Eichhorn first published an identical book in Danzig in 1776; there was an addition, with two newly discovered "water-animals," published in Danzig in 1783, but I have not seen that.

Eichhorn revealed something about himself when he wrote:

> I have applied myself to this invisible world, which makes itself known to us only by way of a magnifying glass, as much as my official duties have allowed; this work has been my companion for 11 years, and in understanding God in his smallest and invisible works, I have found Him to be very great. Yes, believe me when I say, and this even more than that: a large church-clock is certainly an ingenious machine, but a pocket-watch, a watch in a ring, is truly much more, a construction of even greater glory and honor. (Eichhorn 1781)

The three-part "contribution" discusses where the water-animals are found, how one must keep them in a glass on the table and then bring them under "the microscope," and, lastly, the appearance of each of several forms, their appendages and movements, and at which time one can find them.

One of Eichhorn's "eight finely engraved copper plates" had poor figures of a probable harpacticoid (his Figs. K–L) and a cyclopoid (his Figs. M–N, Cyclops sp.). Of these, he comments:

> In this moss or slime are found millions of all kinds of delicate insects, which dwell in it, and find their food and their social diversions; they are without worries, they find plentiful support without trouble; there, instead of weariness and inactivity, one finds that it is full of liveliness and life; in a short time they produce their children and their children's children, and their families are so numerous that they do not at all fear dying-out; you foolish and faint-hearted men, who ask with fear and dread: What shall we eat? What will we drink? We see here many 1000s of creatures, who neither sow nor reap, . . . are they not better-off than you? They are indeed a picture of the Divinity Himself. (Eichhorn 1781)

Certainly the good pastor never wondered what ruthless forces kept the millions in check. A closer or prolonged look would have disclosed Nature red in tooth and claw, and not the fluvial utopia Eichhorn imagined.

In ditches, swamps, ponds in deep woods, pastures, and vegetable fields, Eichhorn found and briefly described a wide variety of plants and animals: desmids, protozoans, polyps, rotifers, bryozoans, cladocerans, copepods, and insect larvae. Of the two copepods, he named the "insect" in Figures K and L the "water-buck." It was found more frequently in "plants" than in "moss." Its head had a dark spot, but he did not know whether this was an eye or a gizzard. On the water-buck's head were two long feelers, also used for swimming. At its tail were two long bristles that were, like the feelers, covered with many side-bristles. Between these two tail-bristles, it carried its completely opaque "body-purse" entirely filled with its belongings, from which the young arose. Eichhorn added that he had never been fortunate enough to see this latter process.

The animal in Eichhorn's Figures M and N was named the "water-louse." Its body was not as long as the previous form, but much broader and more oval. Unlike the former, the water-louse carried two "purses" and was very common in moss; like the former, it moved too fast for Eichhorn to see details.

The water-buck did not swim so much as it flitted from one place to the other. In fact, because of the disturbances it caused, Eichhorn could not observe other animals with it at the same time.

Eichhorn was born in Danzig and died there. He was an amateur naturalist but could be viewed now as an example of a "scientist" from a generation or two earlier than then. He had attended the gymnasium in Danzig before studying theology at Jena from 1741 to 1746. He became an assistant pastor and deacon in Osterwick near the Harz Mountains. In 1761, he took his lifetime post at St. Catherine's. He was said to be untiring in his devotion to the souls of his church and in seeking God in the smallest of His creations. Eichhorn was married and the father of three daughters.

Comparing Eichhorn's copepods with Blankaart's or those of the Gentleman in the Country, one might be tempted to call Eichhorn the Gentleman in the City. It is good that he did not use binomials, so we don't really have to untangle his contribution. Baird (1850), however, said that Figures M–N in Eichhorn's Plate 5 were *Cyclops quadricornis*, which by Baird's time had become a species that accepted everything otherwise unacceptable. Baird believed that Eichhorn's other copepod was a species of *Canthocamptus* (harpacticoid).

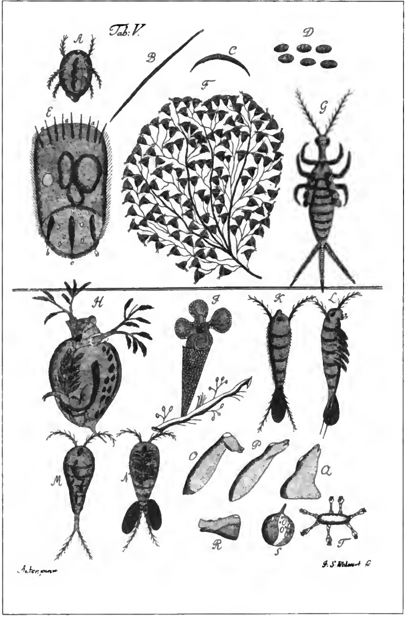
Eichhorn's rotifers and bryozoans are much better than the copepods, but I have seen some recent quasi-scientific handbooks that illustrate copepods at about the same degree of accuracy. I would like to believe that Eichhorn's accessible work made some great impact by inspiring a young Nordmann or other copepodological luminary.

Johann Hermann

31 December 1738–4 October 1800

Johann (or Jean) Hermann's principal fame was as a physician and botanist. He was born in Barr, just south of Strasbourg, in northeastern France (Alsace). His father was a Lutheran pastor. Hermann studied at the Protestant College (Gymnasium) in Strasbourg from 1746 until he entered the university in 1753. By the age of twenty, he had begun a work on the flora of Alsace. At the University of Strasbourg, he addressed philosophy, mathematics, literature, and languages, excelling in the latter two subjects. His studies turned eventually toward medicine and botany, and Hermann received his M.D. in 1762 with a thesis on the history and medicinal properties of cardamom spice (de Morembert 1989).

In 1763, Hermann was in Paris assembling materials for a natural history cabinet. By 1764, he was giving private instruction in natural history.



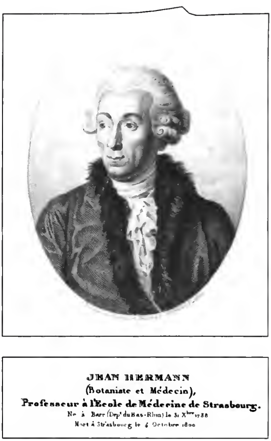
The "water-buck" (Figs. K–L) and the "water-louse" (Figs. M–N), both free-living copepods. From Eichhorn (1781).

In 1768, he became Extraordinary Professor of Medicine at Strasbourg, and in 1778 he obtained the Chair of Philosophy. In 1784, he was named Professor of Botany, Chemistry, and Medicine.

The University of Strasbourg was flourishing in those years, with a large number of good students from many countries, particularly Germany and northern Europe. Most encountered Hermann, and a considerable number retained strong ties. The published lists of the many theses written under his direction reveal a remarkable breadth of inquiry (Cuvier 1817b).

The Revolution's laws of 1795 created the new School of Medicine at Strasbourg, and Hermann's professorship was transferred there. Hermann conducted regular weekly scientific excursions for his students, covering the surroundings of Strasbourg in both Alsace and Vosges. He established a natural history museum, library, and botanical garden. In spite of the Revolution's trying to suppress these institutions, Hermann prevailed by dedicating all his energy and resources to them (de Morembert 1989).

Hermann was in extensive correspondence and exchange with the principal naturalists of Europe, especially Buffon, and he was welcomed into a number of scientific societies. He traveled to Switzerland in 1772 and 1791. He received due recognition in his own France by his election to the first class of the National Institute in 1796, as a nonresident associate. Hermann's brother was Dean of the Faculty of Law at Strasbourg (Cuvier 1817b).


JEAN HERMANN
(Botaniste et Médecin),
Professeur à l'Ecole de Médecine de Strasbourg.
Né à Barr (Dep.t du Bas-Rhin) le 31 X.bre 1738
Mort à Strasbourg le 4 Octobre 1800

Jean Hermann (1738–1800). Courtesy of the Wellcome Institute Library, London.

This vignette represents young naturalists in deep research.

Hermann's life was darkened by the early death of his unique and promising son, Jean Frédéric Hermann (1768–1794) (see Chapter 10). Senior Hermann was thereby desolate in his last years, and he understandably became an implacable enemy of the Revolution and all that it represented. He vented his anger concocting Latin epigrams against the regime. One such was

> Who do we know who refuses to eat with Queen
> Saturnia?[2]
> Does not the voracious and newly hardened Gallia
> join her?
>
> —Cuvier (1817b)

This does not now appear to be incendiary (maybe it has lost something in my translation), but no doubt this was then a dangerous practice. A regime that eats its young? Not a novel concept.

In usual circumstances, Hermann was good-natured, even during a long and painful terminal illness. Among Hermann's papers was a manuscript outlining his belief that the earth had been grazed by a comet, a notion that, for Hermann, explained diverse phenomena (Cuvier 1817b). This seems to be a thought whose time has come again.

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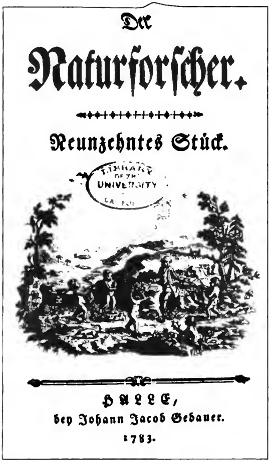
[2] Juno, Queen of Heaven, known for excesses.



Der

Naturforſcher.

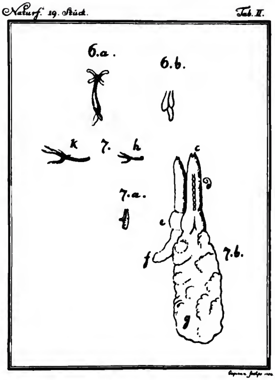
Neunzehntes Stück.

LIBRARY OF THE UNIVERSITY

HALLE,
bey Johann Jacob Gebauer.
1783.

Title page of "The Naturalist," a journal from Halle, Germany (1783).

Hermann (1783) published "Helminthological Remarks" in *Der Naturforscher*, a journal from Halle, Germany. (At the time, there was no natural history journal published in France.) This paper included descriptions and illustrations of *Lernaea lotae* and *L. squamicola*, but according to Wilson (1917a), neither was a lernaeid. The first "worm was pointed out to me by one of my auditors, Mr. Zujef, a Russian." This was found on the gills of the "cod *Gadus lota*" (burbot); Hermann believed it to be a *Lernaea* species, which he did not explicitly name. Subsequent reviewers have assumed the name *lotae* from the host. Hermann's figures were not particularly good. The *Lernaea squamicola* was "very peculiar, and I wouldn't have believed it was a worm if I had not seen it three or four times" as a parasite on a carp (Hermann 1783). In this case, Hermann's figures were slightly better, but neither species is described well enough for a certain identification (Kabata 1979).

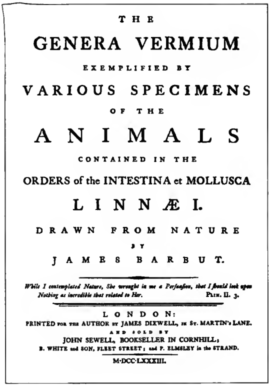


Lernaea lotae *(Fig. 6), a parasite of codfish, and* Lernaea squamicola *(Fig. 7), a parasite of carp. From Hermann (1783).*

According to Kabata (1979), Hermann also reported *Lernaea cyprinacea*, but in this case Hermann had misidentified the *Lernaea* (*Salmincola*) *salmonea* of Linnaeus. At that date, it is not surprising that Hermann included these parasites in memoirs on helminths (parasitic flatworms).

Agassiz (1853) recorded about twenty Hermann publications, from 1775–1804, on worms, corals, shells, fossils, and insects, including "some posthumous zoological observations" published by Hermann's son-in-law in 1804. There is understandable confusion about the Hermann papers, for Johann Hermann's son, Jean (or Johann also) Frédéric Hermann, published on similar subjects over the same time (Swainson 1834). The junior J. F. Hermann's copepod contribution was posthumous, from 1804, and will be addressed in Chapter 10.

Lauterborn (1903), who had access to Hermann's letters and notices, said that Hermann was a man with a very sympathetic personality. Hermann was a Müller correspondent who praised the *Zoologia Danica* but regretted its limited availability (Anker 1950). Hermann was the first to introduce Buffon's



THE

GENERA VERMIUM

EXEMPLIFIED BY

VARIOUS SPECIMENS

OF THE

ANIMALS

CONTAINED IN THE

ORDERS of the INTESTINA et MOLLUSCA

LINNÆI.

DRAWN FROM NATURE

BY

JAMES BARBUT.

While I contemplated Nature, She wrought in me a Perſuaſion, that I ſhould look upon Nothing as incredible that related to Her. PLIN. II. 3.

LONDON:
PRINTED FOR THE AUTHOR BY JAMES DIXWELL, IN ST. MARTIN'S LANE.
AND SOLD BY
JOHN SEWELL, BOOKSELLER IN CORNHILL;
B. WHITE and SON, FLEET STREET; and P. ELMSLEY in the STRAND.
M·DCC·LXXXIII.

Title page of Barbut's Genera Vermium *(1783).*

species, particularly birds, under the Linnaean system. He "was exceedingly well acquainted with the scientific literature of his time" (Stresemann 1920). Hermann's earliest published works in 1776 and 1783 included lists of the affinities of animals (Agassiz 1853). Many of these reports originated in "Argentoratum," the Latin name for Strasbourg. Swainson (1834) said that Hermann was "perpetually confounding the two relations of affinity and analogy"—that is, he brought animals from very different orders close together in these classifications merely because they resembled one another.

In 1773, Hermann was awarded a prize by the Scientific Society of Göttingen for "a memoir on the insects that devour books and archives" (Jourdan 1822b).

The senior Hermann's publications in Germany added to biographical confusion; Packard (1901) said that "In Germany, Hermann was the leading systematic zoologist" around 1790, in spite of Hermann's French residency and citizenship.

James Barbut

?–? 1791

James Barbut published in London in 1783 *The Genera Vermium*, an attractive book of eleven colored plates that included representatives of animals from Linnaeus's Intestina and Mollusca. Although Barbut drew most specimens from nature by himself, he met frustrations in some areas and admitted that

> the residence of many of the animals in this work, their dissolvable nature, and the absolute impossibility of procuring some of them, to be imported from their distant and deep abodes, without mutilation and corruption; obliged the author to have recourse to some of the very few literati on this subject, whole figures appeared from investigation and the author's knowledge, on comparison between those delineated and the real animals, to be correct and amply satisfactory. Scorning to roam among the sweets of science, without declaring the mellifluous genera, from whence he extracted the delicious nectar, he makes public declaration that he has received assistance, from the works of T. Pennant, Esq; Doctor Bohadsch, and the inimitable Seba. (Barbut 1783)

These difficulties were to be faced by all who would study copepods. Barbut's pioneer optimism and fervor were revealed by the apt quote from Pliny on his title page, and also in his own words:

> Let us take a nearer view of them, and our admiration will increase as our ignorance wears away. (Barbut 1783)

No one has said it better in so few words.

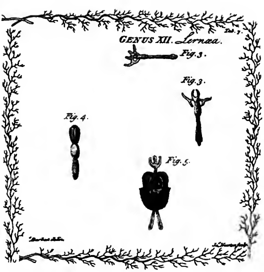
Barbut went beyond a mere embrace of the Linnaean system; he was a dyed-in-the-wool fanatic:

> The immortal Linnaeus, with infinite judgement, has exhibited an arrangement of the testaceous animals, not only generically analogous to the animals themselves, but has preserved the distinctive characters of their habitations likewise, which is certainly the most scientific method; and though certain persons have taken the liberty to criticize the works of this wonderful man, they are as much inferior to him in brilliancy of wit and solidity of judgement, as a glow worm is to the evening star. (Barbut 1783)

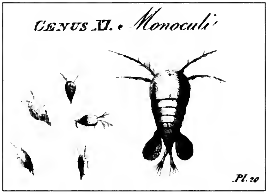
Barbut financed his book through subscribers; the published list of about a hundred included "Sir Joseph Banks, President of the Royal Society," some notable scholars, and a smattering of nobility.

Barbut's Latin, French, and English definitions, and his parallel columns of English and French texts, included the genus *Lernaea*, the twelfth genus in the soft mollusks. Lernaeids, by his definition, have the mouth forward, a body with two or three slender arms (tentacula), and two ovaries like tails. Lernaeids, or "Fish-Plague," affix themselves, by the tentacula, behind the gills or under the fins of various fishes and, like the leech, suck out their nourishment. Like lice in other animals, they prey upon the fish and torture them. Barbut's three featured species, with descriptions and illustrations from Linnaeus, are *Lernaea cyprinacea* (his two illustrations labeled "Fig. 3"), *L. salmonea* (his Fig. 4), and *L. asellina* (his Fig. 5). The first, the carp lernaeid, was reported in abundance from the sides of bream, carp, and roach in many English ponds and rivers. The second species is from salmon; the third is from ling or cod of northern waters, the Latin name of these fish being Asellus. Barbut's colored plates each have an attractive border of hydroids, reconstructed in the condensed example given here.

Barbut is best known for a companion publication on the Linnaean genera of insects that was gorgeously illustrated. In this, Barbut (1781) offered a figure of *Monoculus quadricornis*, reminiscent of Geoffroy. Barbut's text is worth recollecting:


GENUS XII. Lernaea.
Fig. 3.
Fig. 3.
Fig. 4.
Fig. 5.

Three species of "lernaeids" from Barbut's (1783) Genera Vermium.



Monoculus quadricornis, ***shown enlarged beside some cladocerans. From Barbut (1781).***

> Character of the genus. The feet are made for swimming. The body is covered with a crust or shell. The eyes fixed in the shell very near one another. Monoculus quadricornis. Linn. No. 6. The colour of this small monoculus, is rather of an ashen-grey. From the head arise four antennae; two forwards, and two backwards; all four furnished with a few hairs, which give them the figure of a branch. Betwixt the four antennae, quite on the fore part of the head, is situate a single eye. From the head to the tail the body goes down, decreasing in shape like a pear. It is composed of seven or eight rings, which grow continually more straightened. The tail is long, divided in two; each division giving rise outwardly to three or four bristly hairs. The animal carries its eggs on the two sides of its tail, in the form of two yellowish parcels filled with small grains, and which, taken together, nearly equal the insect in bigness. Its feet are placed under the body, but it makes little use of them, the antennae being of more service towards the leaping and skipping which it performs in the water, with great nimbleness. This minute insect, is not half a line in length, and is found in standing pools. A number of them being kept in a bottle of water, some will be seen loaded with their eggs, after a while depositing the two parcels, either jointly or separately. It is called Monoculus, from its apparently having but one eye: the manner in which it proceeds forwards in the water, by leaping, has moreover caused it to be named the Water-flea. Its branching antennae serve it in stead of oars; seldom does it use its legs for swimming. The tail, forked in some species, in others simple, serves them for a rudder. Their colour varies from white to green, and to red, more or less deep, doubtless in a ratio to the fragments of the vegetables on which they feed. The red tincture they sometimes give to the water, has made some ignorant men think that the water had turned to blood. Too weak to be carnivorous, they on the contrary fall a prey to other aquatic insects, even to polypi. Their body, compact and hard, is so transparent that in some the eggs, with which the abdomen is filled, are discernible. . . .
>
> I preserved a pair of these insects, last year, in a small glass (tumbler), the one male, the other female, having a

Franz von Paula Schrank (1747–1835). From Zimmermann (1981).

> bag filled with eggs affixed on each side the abdomen. In the space of fourteen days, the increase was astonishing: it would have been impossible to have taken a single drop of water out of the glass, without taking with it either the larva or a young monoculus. I again repeated the experiment, by selecting another pair, and at the expiration of the last fourteen days my surprise was increased beyond measure. The contents of the glass appeared a mass of quick-moving, animated matter, and being diversified by colours of red, green, ash-colour, white, &c. afforded, with the assistance of the magnifier, considerable entertainment. (Barbut 1781)

Barbut's observations were an admirable if brief summary of the classification, morphology, reproduction, swimming, feeding, and natural role of this wonderful copepod—to him a "considerable entertainment," even though held in dread by "some ignorant men."

I am surprised that there is apparently no substantial biographical material about Barbut. Even the *Dictionary of National Biography* has no entry. I found a few scanty references to Barbut's exhibiting his paintings in popular galleries of the day. The date of Barbut's death is from the library catalog of the Wellcome Institute. Barbut's (1783) preface, in which he states that he would appreciate unusual specimens from anyone, gave his home as "Walcot Place, Lambeth," likely a London district. Even though I cannot yet restore Barbut's faint traces, it is clear that he was one of us.

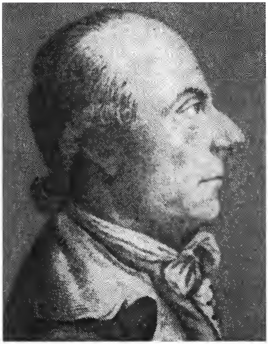
Franz von Paula Schrank

21 August 1747–22 December 1835

In 1783, Franz von Paula (François-de-Paule) Schrank, a German, published in Nuremberg the *Bayerische Reise*, a multivolume natural history guide to Bavaria. There were reprintings and translations of this work, and other dates have been cited, such as 1786 (Baird 1850, Wilson 1915) or 1796 (Nordmann 1832). Oddly enough, the correct Latin translation of "Bayerische" to "Boica" was then incorrectly translated in the French version as "Boheme," and Schrank's work has often been cited as dealing with Bohemia, rather than Bavaria. Schrank added another record of the Linnaean *Lernaea cyprinacea* (see Wilson 1917a) as well as a new species—*L. huchonis*—from the Danube salmon, *Hucho hucho*. "Concerning Schrank's figures, they are rough and sketchy, but still much better than those furnished by Baster for another species" (Nordmann 1832). Agassiz (1854) listed thirty-seven Schrank papers on general natural history and entomology between 1776 and 1829.

Hagen (1863) indicated that Schrank was born in Varnbach, Bavaria (near Scharding, on the Inn, in central Austria), was an ex-Jesuit (not true), and died in Munich as the first administrator of the botanical gardens. According to the title page of an 1803 version of the guide, Schrank was then a Doctor of Philosophy and Theology and a professor at the University of Landshut. Nordmann (1832) referred to him as "the reverend ecclesiastic."

The details between these intriguing highlights of an interesting life have been provided by Wunschmann (1891a) and Stearn (1938). Schrank's father was an ecclesiastical lawyer who sent his nine-year-old son to the Jesuit school in Passau. Schrank did so well there that it was intended that he enter the order. He accordingly became a theology student and novice at the University of Vienna. For his second year, Schrank responded to an old custom by going to a distant college, in this case Oedenburg in Hungary. There he met a priest who had been a missionary in Brazil and who gave Schrank an appreciation of natural history. His studies then took him to Raab (German name for Hungarian Gyor), Tyrnau (Hungarian Trnava), and Vienna, where he followed a curriculum of theology, philosophy, mathematics, and natural history with uniform vigor.



(left) ***Franz von Paula Schrank (1747–1835). From Viets (1955).***

(right) ***Johann August Ephraim Goeze (1731–1793). Courtesy of the National Library of Medicine.***

During a botanical excursion, Schrank became violently ill, greatly affecting an already weakened body. He had planned to be a missionary in India or America, but for his health's sake he was placed as a teacher in the Jesuit school at Linz, where he stayed for four years. However, a papal decree of 1773 suppressed the Jesuits so that there was no hope of advancement within the order. Nevertheless, Schrank returned to Vienna, where he took his holy orders as a priest in 1774. In 1776, he was awarded a theological doctorate.

A return to his family home enabled him to concentrate for a time on natural history and to publish his first reports in 1776. In the same year, he became Professor of Mathematics and Physics at the Lyceums in Amberg and later at Burghausen, both in Bavaria. He was called to the Chair of Agriculture at the University of Ingolstadt, Bavaria, in 1784. His professorship included lecturing on forestry, mining, botany, and zoology. The university was transferred to Landshut in 1800. (In 1826, it was again transferred, to the University of Munich.) Schrank was several times elected by his peers as rector. In 1809, he left the University of Landshut to take charge of the new botanical garden founded by the Bavarian Academy of Sciences in Munich.

Prior to taking on these new duties, Schrank toured Lombardy and Venice with the same enthusiasm he had shown in his trips through Hungary and Bavaria, using Linnaeus's early travels in the Swedish provinces as his model. Schrank's motto was that "Everything is at once the goal and the means." Schrank published more than forty major works and more than two hundred smaller contributions, but he is remembered primarily as a master botanist.

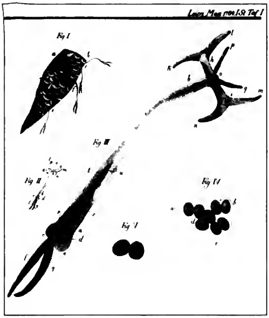
As director of the Munich Botanical Garden, he had a wide correspondence and exchange throughout Europe, the East Indies, and the West Indies, and he made his garden one of the richest of its kind in Germany.

In his last year, he published three substantial theological works, including a history of Christianity in China. He died at his garden at the age of eighty-eight.

Johann August Ephraim Goeze

28 May 1731–27 June 1793

Johann August Ephraim Goeze was another committed theologian who turned toward natural history, combining the themes as he saw them as two sides of the same coin. He was born in Aschersleben (south of Magdeburg) where his father was an evangelical minister (Jourdan 1821b). His early studies were in theology at Halle from 1747 to 1751. Because



Goeze's "fish lernaeid," several shown in situ on the fish (Fig. I), a single specimen at natural size (Fig. II), an enlargement of the single specimen (Fig. III), and groups of eggs from the egg sac (Figs. IV and V). From Goeze (1785).

of brilliant examinations, he became a hospital pastor at age twenty-four. Goeze went to St. Blasius's Church in Quedlinburg, southwest of Magdeburg, as pastor in 1762. In 1786 he was appointed deacon of the collegiate church in Quedlinburg, a post he held for his remaining years (Carus 1879a). Hagen (1862) recorded that Goeze died in Berlin, but I was unable to confirm this.

At the beginning of the 1770s, Goeze by chance encountered a compound microscope made by the Leipzig optician Hofmann. (Ehrenberg also used one, from 1820.) This opened the natural world to Goeze, and from that time he published many contributions of various lengths, including general books of popular interest, some combining his religious beliefs and his naturalist's experiences. Several of his publications were translated, and he himself translated works of others, notably Bonnet's natural history of insects (Jourdan 1821b). Goeze's best-known work was on helminths. A 1782 monograph on worms was "dedicated with the sincerest respect and gratitude" to four "of the great naturalists of his teachers and friends," including "the right honorable and very learned gentleman, Master of Theology Franz von Paula Schrank of the Palatinate-Bavarian Governing Council, true spiritual counselor and Ordinary Public Instructor of Economics and Economic Botany at Ingolstadt etc." (Goeze 1782).

Goeze assembled an impressive collection of "worms" that was purchased by Joseph II (1741–1790), King of Germany and Holy Roman Emperor, and given to the University of Pavia (Jourdan 1821b). This collection rivaled that in the museums of Vienna.

Goeze, while studying mainly insects and parasitic worms, published a paper on "Fischlernaeen" in Leipzig:

> Whether these peculiar worms are as well-known to all naturalists as they deserve to be, I cannot determine. . . . I made this fortunate discovery . . . with my friend the Princely Serene High Justice Olenze zu Schlaben, at Horenburg. This very observant and not entirely inexperienced naturalist, who is provided with his own knowledge, books, and instruments, would willingly have all known species of water-beetles in his cabinet. I suggested to him that we examine a pond, of which there are very many in the beautiful and popular Bocholzischen Garden. (Goeze 1785)

Goeze (1785) found *Lernaea cyprinacea* Linnaeus to be an extremely common parasite on carp in this pond. He gave a good description, with figures, noting that each egg sac contained three hundred eggs ("What multiplication!"). He also saw that individuals did not live long out of the water. Goeze was puzzled over the absence of males among so many females and wondered if they might not be hermaphroditic, or perhaps of alternating sex. He referenced three other Lernaea species: *L. asellina*, *L. branchialis*, and *L. salmonea*.

Agassiz (1853) listed forty-three and Hagen (1862) listed forty Goeze publications starting in 1773. Most of these were on insects and parasitic worms, but there were a few on infusorians, rotifers, and fish. Goeze, in 1776, published a list of Roesel's and De Geer's "insects and worms," showing their Linnaean equivalents. Goeze also produced a nine-volume European fauna between 1791 and 1803.

His brother, Johann Melchior Goeze (1717–1786), was a well-known Lutheran theologian. Even though our colleague shared many of his brother's passions and beliefs, he kept his distance from the controversies in which his brother was involved, and which he considered unpleasant (Carus 1872, 1879a). Johann August Ephraim Goeze cared for the children of a brother-in-law who had died young, and he did not marry until in his forties.

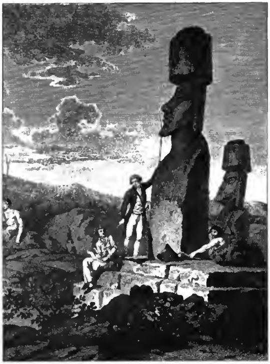
Joseph Hughes de Boissieu de La Martinière

26 January 1758–? 1788

The La Pérouse Strait between Sakhalin and Japan was a major discovery of a classic French scientific expedition. Less acclaimed was the expedition's record of the first definite Pacific Ocean copepods. Joseph de Boissieu de La Martinière was a naturalist in this expedition, sent out in 1785 in *L'Astrolabe* and *La Boussole* under the command of the Comte de La Pérouse (1741–1788). The journals and records of the voyage were dispatched overland to France from Russian Asia in 1787 and by ship from Australia in 1788, so they escaped the subsequent destiny of their compilers. The expedition was last seen at Botany Bay (Australia) in January 1788; it is well known now that this voyage ended in New Hebrides later that year, when the expedition's two ships were wrecked on a reef and every man was officially lost, including La Martinière some weeks before his thirtieth birthday (Gaziello 1984, d'Hondt 1990, Dunmore 1994). However, the disappearance of the La Pérouse Expedition was one of the great sea-mysteries for forty years. The discovery and investigation of the wrecks in the late 1820s brought disclosure from native witnesses of Vanikoro that both ships had struck the reef in a typhoon. Many survivors were killed by the natives in the belief that they had brought the severe storm. About forty others defended themselves as a group and eventually built a small vessel from the wreckage. All but two sailed away to a second oblivion. The two castaways, perhaps already stricken by fevers, lived for a time amid native indifference.

Since there were to be several general naturalists who would share responsibilities on the La Pérouse Expedition, the planners found it necessary to have only one explicit botanist. The selection was Louis Bosc, an important French biologist who has been mentioned before and will be mentioned again before we address him formally in 1802. Possibly his first, but not his last, close brush with death, Bosc declined, and his place was taken by La Martinière. Unconventionally, although it was the custom in some circles, La Martinière, who is known variously as "Lamartinière" or "de Lamartinière," did not transcribe a first name or initial, and so he appears half nameless in the copepod literature.

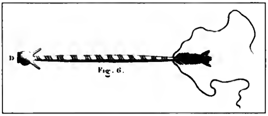
La Martinière was born in Saint-Marcellin (Isère), the ninth child of a physician. He obtained a Master of Arts degree in 1776, followed soon after by an M.D. from Montpellier, in the tradition of Rondelet. An energetic botanist, La Martinière came to Paris as a protégé of Andre Thouin (1747–1824), Professor of Horticulture at the Museum of Natural History. Thouin, in truth, was born in and died in the Jardin du Roi (Cap 1854). La Martinière was known to be acquainted with Bosc and Lamarck, both of whom were destined to serve natural history well and to play a part in the study of copepods. La Martinière's enthusiasm for the expedition's contributions to science shows still in his surviving letters. It is distressing, then, to read that he became melancholy before departure and gained a reputation as a solemn, restless, and not very likable personality (Gaziello 1984). On the other hand, the expedition's second-in-command "infinitely praised La Martinière's social qualities" (Chinard 1937). Perhaps he got along better with the officers than with the sailors.

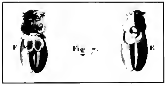


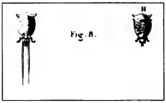
An officer and a scientist of the La Pérouse Expedition examine the Easter Island effigies. The seated scientist, who could be La Martinière, watches a native attempt to steal the officer's hat. "Mr. Duché has given a very exact drawing"; the artist was in a group, including La Martinière, exploring the interior of the island. From La Pérouse (1799).

The detailed records of the expedition's resources revealed that La Martinière was furnished many fine books of his choosing, among which were several by Linnaeus, J. C. Fabricius, and Duhamel du Monceau, and the major works of Barbut and Forskål (Chinard 1937).

Of La Martinière, Agassiz (1853) had only a single reference: La Martinière (1787). This publication contained the first two of three copepods described from the notes sent back to Paris from the voyage of La Pérouse. (That year's journal also printed a letter from Benjamin Franklin referring to naval matters.) The copepod descriptions and illustrations were republished in the slightly better-known Atlas accompanying the printed results of the voyage (La Martinière 1797), with the addition of a third copepod species. By the time La Pérouse's collected results were published, France itself had been shipwrecked on the reefs of revolution, and its world had begun anew; Citizen La Martinière's copepod observations were republished in "Year V."[3]







*"*Pennatula*" species (Fig. 6) and two "*Oniscus*" species (Figs. 7–8). From La Martinière (1797).*

The journals of La Pérouse (up to the departure from Botany Bay) were sanitized of all royal references and incorporated into the official reports. Then like the expedition itself, the journals also vanished, only to be recovered in the 1980s (Dunmore 1994). In spite of its drama and tragic end, the La Pérouse Expedition remains one of the world's epics of discovery.

Because of the obscurity of La Martinière's (1797) record, and its historic importance, I have translated it below:

> The species of *Pennatula*[4] (Fig. 6) appears to me to have some characters that have not yet been mentioned at all; therefore I have made a sketch. Its body is of a cartilaginous substance, and of a cylindrical form: its head, armed with two small horns of the same substance, displays a spherical shape flattened on its anterior extremity; this part is covered with small nipples, of which one sees a part, letter D, and which are so many small mouths by which this animal sucks the blood of fish, from the flesh in which it is embedded as far as it can be. The extremity of its body, which is always outside of the fish, has the form of a quill of a feather: this quill, of the same substance as the body, serves as its excretory duct, of this I am convinced; because, in pressing the animal lightly, most of its cartilaginous quill emits a very clear liquid in small streams. At the base of this quill, and under the body, are set two long cartilaginous threads [egg sacs], of which it is impossible for me to imagine a purpose: they are not always on every animal, because I have encountered some with none at all.
>
> The circulation of the blood is easily observed: a moment is sufficient for a complete cycle. I have tried to copy these undulations by drawing some marks along the length of the animal's cylinder. It is likely that this animal is not able to insert itself into the various fish, except when the animal is very young: and when it finds a time to lock itself in, having then plenty enough to live on, its head enlarges considerably, and the two horns with which it is endowed necessarily constitute an obstacle to its escape; a foresight of nature, since it wants to feed itself, the one is at the expense of the other. I have found them implanted to more than an inch and a half into the body of a *Diodon* in the region near Nootka.
>
> Figure 7 represents an insect of a genus very near to *Oniscus*[5] of Linnaeus: the letter E indicates it as seen from above, and the letter F as seen from below.
>
> Its body is crustaceous, and its color is a dull white, having two round and reddish spots on the anterior part of its corselet, two other very much larger, crescent-shaped [spots], on its back-sheath[6]; its *scutellum* is also the same color. The underside of the thorax is equipped with four pairs of legs: the first and the third pair end in a stoutly pointed hook; in the second [pair], one sees a form, that could serve in swimming; the fourth [pair], very small, consists of two membranous threads. The thin lappets, equally membranous and multi-notched, are also able to function as legs; the two lower are the largest. Its abdomen is filled by a bundle of vermiform intestines, of the size of a hair: its mouth is located between the first and the second pair of legs; it is represented by a small proboscis between two lips joined only at the upper part. I have found this insect attached to the gills of the *Diodon* victim of the two insects I have already spoken about.[7]

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[3] To roughly date these revolutionary-era texts to the rest of the world, add "1792" to the Roman numeral. The system was abolished at the end of Year XIV (21 September 1806). We will see this chronology again.

[4] A footnote here states that "it is likely a *Lernaea*." This footnote was not La Martinière's but was added by the editors of the *Journal de Physique*.

[5] *Oniscus* species are isopods, not copepods.

[6] The text says "elytre," wing-sheath.

[7] Note that here he unequivocally refers to the "*Pennatula*" (Fig. 6) as an "insect"; a previous species

> Figure 8 represents an insect of the genus *Oniscus* of Linnaeus: its body has nearly the form, the consistency, and the color of a wood-louse, except that it is not divided into segments as is the latter. It is provided with a double tail [egg sacs], three times as long as its body: at the insertion of this tail, on the posterior part of the body, there originate two legs that the animal uses mainly for swimming, when it finds itself on its back. The insect seen from the underside, letter H, shows six pairs of legs; the first two pairs end in very sharp and solid points; the third [pair] is used for swimming; and to balance the body in concert with that inserted at the base of the tail; the fourth pair, the largest, is armed with two very sharp points, which the animal implants with great force into the body on which it has attached itself; the last two [pairs] are of a kind of membrane with several segments. Between the first two pairs, is its proboscis, of a soft consistency, and a half-line long: at the base of the third pair, are two points, with a consistency of horn, very hard, very adherent; the two lower horns, underneath the large pair of legs, are equally strongly fixed to its body. I believe that it is with the aid of these kinds of barbs, which pierce the body of the fish upon which it is found, and which otherwise would be an unstable place, that it finds the means to insert its pump into the hole made by these barbs. Put into a vessel, it goes to the bottom and turns around on the surface with the greatest ease, by which it performs as though showing the features of its body and demonstrating the curves. Its two long tails are detached very easily, apparently without the animal suffering. I have found this insect, in large numbers, attached to the body of the same *Diodon*.[8] (La Martinière 1797)

The chance encounter with this sunfish, obviously a floating zoo, provided La Martinière the opportunity to describe not just the first copepod definitely from the Pacific Ocean, but the first three kinds of copepods. He believed that the first species was a *Pennatula*, although his editors added that they thought it was a *Lernaea*. In the beliefs of his era, La Martinière was right; it is clearly a pennellid and therefore belonged to the excessively broad Linnaean genus *Pennatula*, whose copepods are now *Pennella* species.

La Martinière placed his second copepod, from the sunfish's gills, into Linnaeus's *Oniscus*, which was a pretty fair guess. That genus is now reserved for isopods, its original use. Baird (1850), reviewing La Martinière, believed this to be a species of *Cecrops* Leach, 1816. The third species reminded La Martinière of a wood-louse, and his provisional identification as another *Oniscus* should have been retained; however, the editors ended by saying it must be a *Monoculus*, in this case not a bad assumption. It is likely one of the hundreds of species of *Caligus* Müller, 1785, a common copepod parasite of fish.

La Martinière was inspired when he referred to the "*Pennatula/Lernaea*" as an insect. The opinion of the time was that these were worms. Perhaps his creative leap of faith followed from comparing the three very different species side by side. La Martinière was also ahead of his colleagues when he conjectured that the species could not infest the fish in the adult parasite's form, but rather in some (unknown) pretransformed, juvenile stage. His observations on the various behaviors were also unique. Finally, his illustrations, though too small to reveal details necessary for species determinations, are better than most from the period.

Wilson (1917a) and Kabata (1979) both referred to a "*Lernaea cirrhosa* La Martinière, 1798," without providing a literature citation. Wilson indicated only a "1798 Atlas, Pl. 2, fig. 6"; this date is likely from a different calculation for the Revolutionary calendar, but there may have been another version of the atlas with species names added. I do not know of such. In any case, both authors equate this species to Pennella filosa (Linnaeus, 1758). The mystery deepens when another Wilson (1917a) reference to La Martinière is noted, this time to "*Pennatula bocconii*" as a synonym of *Pennella sagitta* (Linnaeus, 1758), again incompletely citing the "Atlas 1798 with Pl. 20, fig. 6." Consequently, I believe that neither of these references to species were made by La Martinière. They were probably named by others using La Martinière's description, but because of La Martinière and the editor's use of both "*Pennatula*" and "*Lernaea*" for the same specimen, both were used by later investigators. That is, the same description and figure were given two different genus and species names. Both Wilson's references are to a Figure 6, one on a Plate 2, the other on a Plate 20. The 1797 publication I examined had Plate 20, Figure 6. This

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(Figs. 4-5) was a monogenean flatworm, *Capsala martinierei* Bosc, 1811, which La Martinière also termed an "insect." There was some irony in Bosc's naming this flatworm for La Martinière.

[8] This insect is more likely to be a *Monoculus* than an *Oniscus*, the shell being of a single piece (added by journal editor).

is *Pennella filosa*. The 1787 publication had Plate 2, Figure 6. This is an identical illustration. None of La Martinière's specimens were *Pennella sagitta*. The kindest thing that can be said about "*Lernaea cirrhosa*" and "*Pennatula bocconii*" is that they should have another author besides La Martinière, and that both are likely junior synonyms of *Pennella filosa* (Linnaeus, 1758).

Jean Guillaume Bruguiere

? 1750?–3 October 1798

Guillaume Antoine Olivier

19 January 1756–1 October 1814

Jean Guillaume Bruguiere was a doctor of medicine and physician-botanist to the king of France, the latter not a safe point to make around the time of Bruguiere's publications. For several years he was an observer of nature in faraway climes amid barbarians. He perished at the very moment he returned to his friends and compatriots, bearing the fruits of his efforts and courage (Cuvier 1819b). The title page of his 1791 work proclaimed that Bruguiere had earned a Doctor of Medicine at the Faculty of Montpellier and was a member of the Montpellier Science Society, the Natural History Society of Paris, and the Société Philomatique (Philomatic Society), as well as being an associate of the Academy of Sciences.

Bruguiere was born in Montpellier around 1750. His father, who was still living at the time of Bruguiere's death, was a surgeon who encouraged his son to study medicine. But Bruguiere chose also to study natural history, neglecting the subject that exposed him to the sorrows of humanity in favor of the subject that pleased him, in spite of its economic uncertainties. Fortunately, the school at Montpellier was the only one in France at that time that offered natural history studies, these under the botanist Professor Antoine Gouan (1733–1821), who skillfully blended the exactness of Linnaeus with the grand descriptions of Buffon (Cuvier 1819b, Davy de Virville 1954). The University of Montpellier, Rondelet's own, dating from 1289, had an excellent reputation, and Montpellier's botanical garden, dating from 1593, was the oldest in France.

Bruguiere's father did not approve of his son's forsaking medicine, and he interfered, arranging a marriage in 1772 that lasted only three months. Bruguiere then fled to Paris to take up botanical studies, which he loved more than his new wife. With his father in hot pursuit, Bruguiere, in a time-honored tradition of young men with troubles, opted for a life at sea and to a faraway *Terra Australis*.

In the France of 1772, still under Louis XV, the government planned to continue explorations in the southern seas. Two vessels under the command of Yves Joseph de Kerguelen-Trémarec (1734?–1797) were sent to traverse the high southern latitudes of the Indian Ocean. Bruguiere was recommended as the expedition's botanist by the two Jussieus, uncle and nephew. Expeditions at that time had objectives toward expanding commerce, in addition to the heroic discoveries of new lands. The result was a conflict between general and specific purposes, and Commander Kerguelen was afterward accused of many crimes and sentenced to twenty years in prison. Bruguiere was called to testify, and thus was caught between his responsibility to science (which was not nurtured on this two-year cruise) and his respect for military discipline. He told of suffering endured and opportunities lost, yet he managed to aid Commander Kerguelen in avoiding the unjust reception. The memory of this voyage abides in Kerguelen, the large subantarctic island that they discovered.

Bruguiere collected many rare plants during the cruise, but he was also attracted to mollusks, worms, and zoophytes of the tropics, which had been little studied in France. Bruguiere managed to obtain a small stipend from the government, and he stayed nine months in Paris working on his collections. He then returned to Montpellier. Bruguiere was attached to the Academy at Montpellier, and he also taught at the university. He remained there for several years and continued his studies, working primarily on the botany of the South Seas voyage. He was diverted for awhile with fossils from a new coal mine near Montpellier, and he described these and compared them to fossils already in the region's cabinets. In a 1792 paper, Bruguiere explained in a rather modern way the extraordinarily slow formation, under a warmer climate, of the coal deposits, and he rejected the prevailing cataclysmic view (Packard 1901).

Bruguiere went again to Paris at the end of 1781, with the intention of continuing his research and having it published. He hoped to do as well there as he had in Montpellier, and his acquaintance with a number of scholars prepared his way. The Linnaean Society of Paris, founded in 1788 by the physician/naturalist Pierre Marie Auguste Broussonet (1761–1807), included among its charter mem-

GUILL.me ANT.ne OLIVIER
(Voyageur et Entomologiste,)
Membre de l'Académie des Sciences

Guillaume Antoine Olivier (1756–1814). Courtesy of the National Library of Medicine.

bers Bruguiere and Olivier as well as the government minister Roland (see Chapter 10), Lavoisier, Daubenton, and Lacépède (Lamy 1930).

Daubenton, Buffon's patriarchal assistant who had taken up Linnaeus's "worms" for the *Encyclopedie Methodique* then being compiled, became aware of Bruguiere's work in this field and judged it to be far ahead of his own. Bruguiere was asked to address these sections, and he established this mishmash group of invertebrates on a stronger footing than they had been in France up to that time. In his introductory pages, Bruguiere informed his readers that

> If the study of Vers still does not present the same interest as the other areas of Natural History, it is not because they combine less attraction, less fertile discoveries, or less useful products than the areas of nature that have been observed more; rather it is the difficulty of observation, the poverty of libraries, and above all the want of collections, occasioned on the one hand by the obstacles without number in their research, and on the other hand by the resistance to preservation of the individuals that chance presents so rarely, and finally by the indifference of naturalist voyagers; these are the true causes. (Bruguiere 1791)

Bruguiere doubled and tripled the numbers of species previously reviewed from various orders, added new species, and sharpened the defining characters, so that the Class Vermes was raised to a higher level of visibility and understanding, and the stage was set for the famous *Dictionnaire* of the next generation. Bruguiere omitted some species because, in his opinion, they were inadequately described or were *varieties* rather than species.

Fifty years later, Bruguiere was evaluated by an English admirer:

> Even in France the Linnaean system soon became little less predominant under the leading of Bruguiere, but the regard the French paid to it was of a less slavish character than it had assumed in Britain. Bruguiere, though a Linnaean in principle, carried forward in some degree the system of his master. . . . But he made no effort to . . . detain the science at the stage where Linnaeus had left it. (Anon. 1838)

Bruguiere did not seem to make friends easily, although those he had were fiercely loyal. He does not appear to have been a recluse; possibly "single-minded introvert" would be a better description. One of his best friends was the kindly Lamarck, not yet a zoologist. In 1790, Lamarck requested that the National Assembly provide a position in the Natural History Cabinet of the Jardin des Plantes for "Insects" and another for "Vers etc.":

> By happy circumstances there now exist in Paris two persons of the highest merit in natural history, and each embraces an extensive knowledge of this noble science. Of these two distinguished scientists, one is particularly appropriate for a general study of insects, the other to embrace that part of natural history so vast it is poorly known, which encompasses the Vers, whether *naked* as the Infusoria, the Intestinaux, and the Mollusques, or *shelled* as the manifold order of Coquilles, or *lithophytes* as the Madrepores, the Millepores, etc., etc., or finally *zoophytes* as the Gorgones, the Corallines, the Alcyons, etc., etc. It is not my point here to name the two scientists of whom I speak. In fact, the

> time when one would use entreaties, [or] intrigue, as if taking the place of their relatives, their friends or their dependents, in order to conceal the mediocrity of their talents or their knowledge, has without doubt passed. . . . With regard to the two scientists in question, the work that they have undertaken and in part accomplished is so well known that it designates them. It is sufficient for me to say to the August assembly of the representatives of the Nation that they can find in this capital two very worthy persons to be entrusted, at the Natural History Cabinet, with the necessary work on the Insects and on the Vers. (Lamarck, qtd. in Landrieu 1909)

Everyone knew that these two naturalists were Bruguiere and Olivier. But in spite of Lamarck's unprecedented appeal, the Assembly, in August the same year (1790), designated Lamarck, the botanist, to be the future Professor of Insects and Vers. This was formalized by the decree of June 1793 that established the Museum of Natural History.

When Lamarck took up the invertebrates in 1793,

> on one group he was a little prepared, but it was by accident; a self-sacrifice to friendship was the cause. For it was both to please his friend Bruguiere as well as to penetrate more deeply into the affections of this very reserved naturalist, and also to converse with him in the only language which he wished to hear, which was restricted to conversations on shells, that M. de Lamarck had made some conchological studies. Oh, how, in 1793, did he regret that his friend had gone to Persia! (Geoffroy, qtd. in Packard 1901)

In 1791, together with Lamarck, Haüy, and Olivier, Bruguiere began the Natural History Society of Paris and also the *Journal d'Histoire Naturelle*, which had two quarto volumes its first and only year (1792). This was the first French periodical dedicated to natural sciences (Landrieu 1909), but it ended as the Revolution carried away its subscribers and as adventure carried away Bruguiere and Olivier. Cuvier (1819b) said in 1799 that it was a disgrace that France, with all its great naturalists and beautiful natural history collections, still did not have a periodical dedicated to this science. (This was remedied by Audouin and colleagues in 1824; see Chapter 13.) In Germany, with lesser governmental patronage, poorer collections, and "nearly worthless instruction, there are at this moment a score of journals dealing solely with this subject" (Cuvier 1819b).

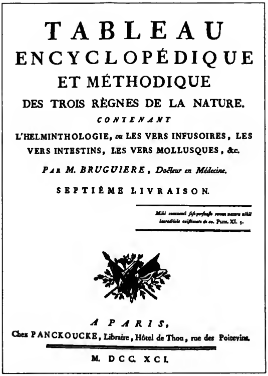

TABLEAU
ENCYCLOPÉDIQUE
ET MÉTHODIQUE
DES TROIS RÈGNES DE LA NATURE.
CONTENANT
L'HELMINTHOLOGIE, *ou* LES VERS INFUSOIRES, LES VERS INTESTINS, LES VERS MOLLUSQUES, &c.
PAR M. BRUGUIERE, Docteur en Médecine.
SEPTIÈME LIVRAISON.

A PARIS,
Chez PANCKOUCKE, Libraire, Hôtel de Thou, rue des Poitevins.
M. DCC. XCI.

Title page from Bruguiere's (1791) summary of parasitic copepods, classified by him under the Vermes Mollusca.

Bruguiere avoided the perils of the Reign of Terror from an early time. He retired modestly to the suburbs near the Jardin des Plantes and stayed for many weeks, occupied with his work. Even though he was a founder, he seldom even attended meetings of the Natural History Society. Others followed his example, accelerating the demise of the group. Perhaps this was inevitable in those uncertain, suspicious times.

Guillaume Antoine Olivier's life ran virtually parallel to that of his colleague, Bruguiere. Olivier authored a 1792 entry on *Monoculus* for the *Encyclopedie Methodique* (Vervoort 1986b). In this sense, Olivier did for the free-living copepods precisely what Bruguiere did for the parasitic forms. Olivier was born at Arcs, near Toulon (Bonnet 1945). He attended the University of Montpellier and was a student of the same curriculum, earning the same Doctor of Medicine, as Bruguiere (Cuvier 1819a). And like Bruguiere, his passion was not medicine but natural history. Olivier was a good botanist, although his specific field became entomology.

In 1783, during a government reorganization of the Agricultural Society and Veterinary School of Paris, Olivier was added to its staff. He remained there for several years, describing the natural productions of France (climate, sunshine, plants, and animals in relation to agriculture and industry). Most of these records were destroyed in the pillage of the Revolution.

Before the Revolution's disruptions, Olivier also worked on a project for a wealthy man to describe the insects of Europe and was sent to England and Holland to examine specimens. This brought Olivier to the attention of the publishers of the *Encyclopédie Méthodique* in 1789, when he was asked to take on the insect volume. The encyclopedia was meant to be an alphabetical summary that interested amateurs could use; at that time, there was nothing like it in France. When Olivier subsequently departed for the Orient, he had reached the letter "E." Even though the long voyage was tiring and dangerous, the Revolution at home was then running its equally dangerous course.

France was divided by the Revolution, and emigration had begun. The encyclopedic literary effort was halted and nearly ended by the destruction of the printer's records. Olivier had been somewhat involved with politics, in the opposition toward the momentarily winning side, and so felt it prudent to leave Paris. Because of their similar positions and scientific backgrounds, Bruguiere and Olivier were able to join an official expedition as the two naturalists to explore the Ottoman Empire. This was not an unlikely combination, for Bruguiere and Olivier were then the only two prominent French zoologists (Packard 1901).

Unfortunately, "these two, poor, distant naturalists" were essentially abandoned in their task by a government overwhelmed at the time by momentous foreign and domestic problems. Bruguiere and Olivier left Paris at the end of November 1792, remaining four months in Marseille and Toulon until they found a ship to take them to Constantinople. En route, they were detained in Bosnia by the recall of an accompanying administrator. His replacement was ignorant of Bruguiere and Olivier's mission and demanded instructions from Paris before they could proceed. "Our two naturalists were nearly desperate," but they occupied themselves with short excursions observing the customs and resources of the resident Turks and Greeks and the ruins of ancient occupants (Cuvier 1819a).

Bruguiere was of a temperament and constitution that made him unable to resist the fatigue of the expedition, and much fell to the younger Olivier. However, I hasten to add that they remained lifelong friends, so I do not perceive that Bruguiere's temperament was a significant character flaw. At forty years old, Bruguiere was overly heavy, if not obese (Lamy 1930), and apparently he was in no condition to commit to such a rigorous journey. That he stayed with the task is a credit to his will and to the forbearance of Olivier, but as events sadly proved, Bruguiere paid the highest price.

Impatient to get on with their mission as naturalists, they decided to risk the consequences of proceeding to Asia Minor without government financial support or protection. Moving from one escapade to another, in a sort of three-year latter-day odyssey through the Ottoman Empire, the travelers skirted assassination, industrial espionage, international plots, and incessant treachery and bribery. When they reached Egypt, the resentment there toward foreigners compelled their speedy retreat to the not-very-friendly Constantinople. In spite of their troubles, Bruguiere and Olivier managed to collect a large number of plants and animals, especially shells and reptiles.

A pleasant surprise awaited them in Constantinople in the form of a new French minister with authority for reimbursement and with new orders for the intrepid team to explore Persia. The new assignment was no respite, for Persia, too, was a hotbed of strife. After two centuries under one dynasty whose last ruler was "voluptuous and cruel," the nomadic Afghans had violently seized power (Cuvier 1819a). Then followed a series of assassinations, massacres, and civil wars. Bruguiere and Olivier arrived in the midst of major warfare, pitting a western faction supported by Russian Georgia against the brigand chief of the eastern faction, Mehemet Khan. The fact that Russia was then aligning with European powers against France gave the two Frenchmen a curious and unexpected prestige in Constantinople and Persia.

Bruguiere and Olivier went to Syria in October 1795 and visited the ancient ports of Beirut, Sidon, and Tyre. They then traveled by caravan to Aleppo, northern Mesopotamia, and Baghdad. In Baghdad, the two naturalists, both with medical doctorates, became players in a tale worthy of the "Thousand and One Nights."[9] The pasha, Suleiman, was believed to have a mortal illness. All the Middle Eastern remedies and astrological treatments had been useless. Bruguiere and Olivier cured him in three days, and the public acclaim they received noticeably expedited their way through Persia.

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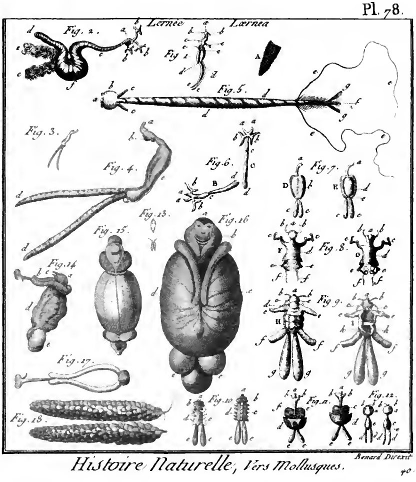
[9] In 1796, the National Institute, encouraged by collections and notes returned by Bruguiere, elected him a nonresident associate (Lamy 1930).

One of the Persian areas least known to Europeans was the mountains to the north, around the present capital of Tehran. Here Bruguiere and Olivier recorded unfamiliar natural resources, but Bruguiere's declining health shortened their stay. Their departure for Baghdad in September 1796 was no doubt hastened by the slaughter of a hundred Russian sailors who had been captured on the Caspian Sea and whose corpses adorned the palace walls.

With the assassination of Mehemet and a renewal of the intense civil war, Bruguiere and Olivier now encountered new troubles and were often in the gravest danger of their entire journey. In Baghdad, with the government officials' recollection of the healed pasha, the pair was obliged to care for other sick persons for six months before they could escape by caravan. They returned to Aleppo by a different route, eventually reaching the Mediterranean coast and boarding a ship for Cyprus. They then backtracked to Constantinople, where they spent eight months caring for their collections and notes.


Pl. 78.
Lernee
Lernea
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10
Fig. 13.
Fig. 14
Fig. 15.
Fig. 16
Fig. 17.
Fig. 18.
Fig. 22.
Fig. a.
Histoire Naturelle, Vers Mollusques.
Benard Direxit
40.

Figures of parasitic copepods cataloged by Bruguiere (1791).

Their return to France was delayed by a tour of principal sites in Greece and along the Mediterranean route. The pair reached Ancona, Italy, near the end of September 1798, where Bruguiere, never in good health since their entry into Asia, died soon after going ashore. It was believed that he had contracted some "malign fever" while in Constantinople. Cuvier, and others who also expected much from Bruguiere, said this was "a great loss to natural history." Olivier, alone, returned to France after a six-year absence. Three months later he was named a member of the Academy of Sciences, replacing Daubenton. Olivier became Professor of Zoology at the Veterinary School in Alfort.[10] Olivier filled the next ten years working on the insects collected during the Persian expedition and editing the narrative of the journey. Thousands of specimens were dispersed for study by other scientists. Olivier died in Lyon in 1814 (Bonnet 1945).[11]

Bruguiere was one of the popular zoological encyclopedists, blending some firsthand learning with generous doses of secondhand observations. Packard (1901) called Bruguiere a "conchologist of great merit" whose descriptions were clear and precise. Bruguiere's field also included "worms" of all kinds, embracing many if not most that would not be so characterized today. This is true especially of several parasitic cope-

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[10] The Alfort school, a few miles east of Paris where the Marne flows into the Seine, was begun in the late 1760s, among several military reforms and innovations (Elting 1988).

[11] Most records of Bruguiere's dates state that he died in 1799. Undoubtedly this stems from Cuvier's 30 January 1799 address to the Societe Philomatique, in which he pointed to the death "this year" of Bruguiere. By the time Cuvier's eulogies were collected and published, the awkward Revolutionary calendar had been converted and forgotten, but when the address was given, "this year" had extended from 22 September 1798. Cuvier's eulogy for Olivier gave the time of Bruguiere's death as "almost suddenly after they disembarked at Ancona on 24 September 1798"—that is, at least two days into the new year (An VII) of the Republic. Lamy (1930), a careful scholar, gave Bruguiere's final day as 3 October 1798.

Chrétien inv. du Physionotrace rue St honoré l'Oratoire à Paris

André Jurine (1780–1807), son of Louis Jurine and author of an impressive early memoir on argulids. Portrait ("Physionotrace") courtesy of Bibliothèque Publique et Universitaire, Geneva, and François Martin, photographer.

pods included in Bruguiere's (1791) extensive "Encyclopedic Table of Nature, Worms." These "lernaeids" (shown in Bruguiere's Plate 78) were inserted within the Order Vers Mollusques, or soft mollusks, following many prominent naturalists. By this system, the parasitic copepods had such companions as coelenterates, tunicates, pteropods, cephalopods, and hagfishes.

In 1789, Bruguiere published the first part of the text for his contribution to the *Encyclopédie Méthodique* (Volume 1, the "Natural History of Vers," pages 1-344). The remaining part of the text (to page 758) was published in 1792. This is a rare volume, and one that I have not seen; references to it are confused and convoluted. I do, however, have Bruguiere (1791), the *Tableau Encyclopédique et Méthodique*, apparently the vehicle chosen for the publication of the plates for Bruguiere's 1789 and 1792 encyclopedic text. The *Tableau*, too, invites bibliographic uncertainty because it also was published in two parts: pages viii and 1–83 plus plates 1–95 in 1791, and pages 85–132 and plates 96–189 in 1792 (Sherborn and Woodward 1906). The pages of the *Tableau* contain the explanations of the plates, in parallel French and Latin. My example, therefore, has the copepod plate but is lacking its explanation. After Bruguiere died, Lamarck took over the compilation of the Vers, as well as the editing of the whole *Encyclopédie*—plants and animals. When he died, Bory de St. Vincent accepted the task. Additions to the work appeared until 1832.

Bruguiere (1791) illustrated the lernaeids (in the broad sense) with eighteen figures on his Plate 78. He defined the genus *Lernaea* as having a naked body, filiform arms, and a posterior terminated by two linear ovaries. He redrew all six of Gissler's (1751) copepod figures (Figs. 13-18). The rest, some better and some worse, he copied from Linnaeus's 1747 account of West Gothland (Fig. 11), Müller's *Zoologia Danica* (Figs. 1, 3-4, 7-10, 12), Barbut (Fig. 6), and La Martinière (the pennellid, Fig. 5). I do not recognize Bruguiere's Figure 2, which may be an original figure or a redrawn *Lernaea gadina* from Müller.

Agassiz (1848) recorded eleven Bruguiere publications on worms, mollusks, reptiles, and the "Three Kingdoms of Nature." One publication was co-authored with Lamarck. An 1827 second edition of the "Encyclopedic Table" was attributed to Bory de St. Vincent, who is reviewed in Chapter 13.

Louis Jurine's Early Work

If it were not for Louis Jurine's fabulous monograph on the entomostracans of Geneva in 1820, he would be a mere dust-mote in the history of copepodology. Apparently, there were two early *copepod* papers, abstracts of ongoing work with Monoculus (= *Cyclops*) *quadricornis* and *M.* (= *Diaptomus*) *castor*, published in the first two volumes of the *Bulletin des Sciences par la Société Philomatique* between 1791 and 1797 (Desmarest 1825, Agassiz 1848, Vervoort 1986b). Jurine noted that the juvenile *Cyclops* differed greatly from the adult form and that they were in fact the *Nauplius* and *Amymone* of Müller. Jurine did not refer to these publications in his monograph, and whatever was said earlier was hugely overshadowed.

Jurine's youngest son, André Jurine (1780-1807), published in 1806 a pathfinding work on the argulids: "Memoire sur l'Argule foliace (*Argulus foliaceus*)" by "Jurine fils" (*Annales du Muséum d'Histoire Naturelle* 7:431-58, pl. 26). All subsequent authors have attributed this paper to Louis Jurine, based on the probability that at that time he was a "fils" (son). I also followed this convention until I was informed that there exists a reprint of this work that had been inscribed by the author, André Jurine, and given to Cuvier (C. Mac Arthur, pers. comm., December 1997). Within the copepod community, it has taken nearly two centuries to clarify this authorship due to the deplorable practice of signing publications with only the family name. (André Jurine, whose life ended

Peder Christian Abildgaard (1740–1801). From Anker (1950).

tragically, was important in the equally short life of Delaroche and is mentioned again in Chapter 10.)

Baird (1850) said that the argulid paper gave the "most elaborate description." Wilson (1902) described this first and very clear account of the development of argulids. That the Museum of Natural History in Paris published this paper by an outsider was a measure of its even-then-realized value. Undoubtedly Louis Jurine had some influence in this report; the publication is mentioned here because argulids were held to be copepods for a long time, and many investigators worked on both groups. There are few species of argulids, so it is relatively easy to track their history (Wilson 1902).

Peder Christian Abildgaard

22 December 1740–21 January 1801

Peder (Peter) Christian Abildgaard, another Dane, was the founder of the scientific veterinary school at Christianshavn, which later became a royal college (Wolff 1979). We have already met Abildgaard briefly in his relationship to Müller's *Zoologia Danica.* At his teaching post, Abildgaard was allowed to conduct lifelong natural history studies, mostly regarding intestinal parasites, leeches, and protozoans, but he also touched upon parasitic copepods.

In 1794, in the same issue of the *Skrifter* that included Otto Fabricius's "gill-worm," Abildgaard described a "gill-worm," *Lernaea anomala,* parasitic on bream (Vervoort 1986a). This species is now *Clavella* anomala (Abildgaard, 1794), in a different order (Siphonostomatoida) from that in which the true lernaeids are placed (Cyclopoida) (Wilson 1917a, Kabata 1979). In the previous paper in this issue of the *Skrifter* (Vervoort 1986a), Abildgaard reported two new species of "*Monoculus,*" both new species in Müller's genus *Caligus, C. oblongus* and *C. crassus. Caligus oblongus* is now *Dichelesthium oblongum* (Abildgaard, 1794), the only species in the siphonostome genus *Dichelesthium* Hermann, 1804 (see Kabata 1979). *Caligus crassus* is now *Anthosoma crassum* (Abildgaard, 1794), the only species in the siphonostome genus *Anthosoma* Leach, 1816 (see Kabata 1979). Krøyer (1852) cites one or two other Abildgaard papers, also from the *Skrifter,* that may have descriptions of parasitic copepods.

Jens Rathke

ca. 20 November 1769–28 February 1855

Jens Rathke was mentioned in the previous chapter as one who helped publish O. F. Müller's remaining sections of *Zoologia Danica.* Rathke was a strongly original personality, perhaps even eccentric, who gained and gave through many personal contacts. He had numerous friends, including a bishop and others in high places. Rathke was born in Christiania of a merchant father when Norway was part of the Danish kingdom. Like so many of his contemporaries, regardless of the field for which they were destined, Rathke (in 1787) became a student in a local cathedral school. He soon took up his studies in Copenhagen and passed his theological examinations there in 1792. He then became interested in natural history through contacts at the Natural History Society of Copenhagen (Spärck 1933) with Martin Vahl and Peder Ascanius, both students of Linnaeus.

Rathke's first major independent effort was a survey of the natural resources and economy of the long Norwegian coastline from Bergen to Lofoten. The resulting publication, dealing mainly with fisheries, brought him recognition and is one of the foundations for the strong Norwegian fisheries science that followed.

An interesting letter from Vahl to Rathke survives from 1796:

> I had two letters from you waiting for me when I returned some days ago from Holstein. I owe you a great many thanks for the friendly way you are pleased to remember me and from taking every opportunity to

> report to me your progress on your publication. If I have contributed something to your knowledge of natural history, then I am pleased, but I can offer you nothing more of value after that, however much it is deserved; that will come through what you yourself have laid your hands on, and it therefore belongs to you yourself and not to me. However, I should yet admit to you that this flatters me very much that we still find here with us a true affection for science, by investigating Nature within Nature and not in the review of books. I am sorry enough that in these few years I have been with the Society that I have seen a great number that either worry themselves no further about Science or instead study it from a wrong aspect, or come to knowledge only by standing on the shoulders of others. In doing so, however, they always see half of what is in Nature. Therefore, my dear friend, continue as you have begun; rewards lie in the work. Keep me informed of your observations, so that I may have a reason to be pleased. I hope that the proposals including trips to the North Sea coast turn out according to your desire. This will give me and several that teach, and who know a part of Nature, an opportunity to yet learn of that which still lies hidden in darkness. I look to you then to teach us all to know these strange creatures of Nature. Everybody else will be envious. From my heart I wish you a happy mind and everything that can contribute to the goals for the journey you have so fortunately commenced.
>
> Concerning the instructions you require, you need not worry yourself much about these. Many contributions have come from people who have never traveled, never collected, never investigated Nature, and I maintain that much of this comes from strong men. Any benefit of instructions, however well informed, still depends on the traveler and the reasons he travels. If for his honor, he will well-enough fulfill his duty; but one for whom money alone matters will achieve nothing, even if he has 10 instructions. . . .
>
> I wish you all well and I remain yours sincerely, M. Vahl. (Vahl letter, qtd. in Daae 1876)

Rathke sailed to Madeira in 1798 and the following year to Lisbon, returning to Copenhagen in 1800 by way of Spain and France. In France, Rathke studied under Cuvier, absorbing in particular Cuvier's scientific methods. Rathke immediately set out for his next serious adventure, a two-year exploration from northern Norway to Murmansk, Archangel, and St. Petersburg. It was after this travel, from 1802 to 1806, that Rathke devoted time to editing Müller's and Ascanius's unfinished works.

Jens Rathke (1769–1855). Courtesy of the Zoological Museum, University of Copenhagen.

Rathke was named Professor of Natural History at the University of Copenhagen in 1810, but he was called to the new University of Christiania (from 1811), and so returned to the city of his birth. Rathke became the University of Christiania's first Professor of Zoology in 1813 and thus was a part of the foundation for academic marine studies in Norway. Rathke's counterpart, Christen Smith, named Professor of Botany at the same time, soon came to a tragic end in the service of science; Smith will be mentioned in Chapter 10 in connection with the great English carcinologist Leach. After Smith's death in 1816, Rathke was obliged for a time to teach botany as well as mineralogy. He is remembered in Norway for "Rathke's legacy": for his practical, productive, and active (if not restless) early life, and for his substantial bequest to the University of Christiania for studies of Norwegian zoology (Daae 1876, Broch 1954).

When Rathke left the University of Copenhagen, Johan Christopher Hagemann Reinhardt (1776–1845) became the first Professor of Zoology, beginning a long and fruitful career that passed to Steenstrup of copepod fame. Reinhardt was, like Rathke, a student of both Vahl and Cuvier, and continued to correspond with Rathke as a close friend (Daae 1876). Perhaps Rathke's best-known student from the University of Copenhagen was the botanist Joakim Frederick Schouw (1789–1852).

In 1797, Rathke named and published the first description of the "glochidium" larvae of the freshwater mussel, which he believed were merely mussel parasites (Cole 1944).

By the time Michael Sars encountered Rathke, in 1823, the fire of Rathke's youth was gone, at least with respect to pure zoology as Sars saw it. Sars's studies at the University of Christiania were not especially strengthened through the standard curriculum:

> The esteemed teacher [Rathke] and natural-historian had been a promising naturalist in his younger days. I believe that now, as has long been well-known, he no longer has a great interest in his subject; his lectures are dry and boring. I found neither guidance nor encouragement with him, and in this way must now be a former student in my struggle alone, as my old rector said [in Latin], by my own hand. (M. Sars letter, qtd. in Økland 1955)

Fortunately, Sars saw the wisdom of remaining with the traditional program and finding his "guidance and encouragement" with other professors and fellow students, some of whom were Rathke protégés. In so doing, he nearly chose geology and paleontology, rather than the marine zoology for which he is deservedly remembered (Økland 1955).

Ludvig Daae (1834–1910), Professor of History at the University of Christiania, had a different understanding, saying that Rathke was an eager scientist and a noble, generous man for whom his numerous friends in both Denmark and Norway had high praise:

> He had, however, the misfortune to be the sole teacher of natural history at a time when everyone wanted only utilitarian courses in the Norwegian university, when his support often was required in affairs unrelated to his subject, and so he could not achieve anything for his science that he likely could have under a more favorable situation. He waited long for the day of his retirement, and in the last years of his position with the University he was apathetic and frail. This is the reason that the contemporary generation is sometimes inclined to underestimate his cleverness and merit. (Daae 1876)

We have a quick glance at Rathke again, in 1833, when Edward Forbes visited Norway:

> The capital of Norway is a peculiarly favourable station for the naturalist. The flora of its neighbourhood can vie with that of any university town in Europe: the entomologist may there exert with success all his beetle and butterfly catching propensities, and the student of ichthyology, of the Mollusca, and the Crustacea, will find ample occupation amongst the inhabitants of that fiord from which Müller drew so many of his discoveries. In its university he will meet with Esmarck, Hanstein, Rathke, and Blyth, all men imbued with the true spirit of the naturalist, and glad to render him every assistance in their power. (Forbes 1836)

Forbes intended to spend most of that trip botanizing, with some little time for natural history studies from a small boat in fjords. It was recorded that Forbes visited the University of Christiania botanical gardens with a botanist and Professor Rathke (Wilson and Geikie 1861). Rathke, a lifelong bachelor, retired in 1845 and remained in Christiania until his death in 1855 (Daae 1876).

In his early days at the Natural History Society of Copenhagen, Rathke (1799) published in the *Skrifter*[11] some "Observations regarding the natural history of parasitic worms and molluscs." Included in this report was one species of *Lernaea*, which Rathke grouped with his mollusks. Although there were several good figures of other organisms, Rathke did not illustrate the copepod. He said that it agreed well with Strøm's Figures 7 and 8 (*"Lernaea adunca"*) from Søndmør, with some small differences. Rathke said that his specimen had a white body but was black around the mouth, and the egg strings were reddish-yellow.

We will encounter another copepodologist named Rathke, Martin Heinrich Rathke (1793–1860), whose several studies of crustaceans will be featured in our review of the copepod contributions of the 1830s.

Hans Severin Holten (1770–1805), silhouette from Henriksen (1923).

Hans Severin Holten

11 July 1770–30 December 1805

Hans Severin Holten, Abildgaard's nephew, was also introduced earlier as a zoologist who worked on the uncompleted *Zoologia Danica.* Holten (1802) published descriptions, presented at the February 1800 meeting of the Copenhagen Natural History Society, of two new "lernaeids." In summer 1799, Holten had gone to Helsingør, his birthplace, and caught the rare fish John Dory (*Zeus guttatus*) with a fisherman's bottom net. A member of the Natural History Society of Copenhagen had recently described this fish in its journal, and Holten had compared his specimens with those and with Strøm's. There were some differences that Holten attributed to states of preservation, but he declared that all specimens examined were of "one and the same species." He included a good review of the literature on the genus *Zeus*, listing some old and now familiar naturalists' names.

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[11] This *Skrifter,* the first solely natural-history journal in Denmark, was founded by Martin Vahl in 1790 (Wolff 1979).

The last two or so pages of the report included Latin descriptions and figures of the two new "gill-worms." The first species was the "gill-borer" *Lernaea merluccii* (Fig. 2 in Holten's Tab. III), from a codfish (*Gadus*); Holten said that it was like Müller's *L. radiata* from *Coryphaena*. The other was the "gill-lernaeid" *L. exocoeti*, from the flying-fish *Exocoetus volitans*; Holten received this specimen from Abildgaard, to whom it had been given by a Professor Olufsen. Holten recognized that it was similar to the Nootka Sound "lernaeid" (pennellid) described by La Martinière, and he provided an illustration at natural size (shown in his Fig. 3, Tab. III), although the copy reproduced here may have undergone some enlargement or reduction. These species are now *Chondracanthus merluccii* (Holten, 1802) and *Pennella exocoeti* (Holten, 1802) (see Wilson 1917a). Holten puzzled over the apparent close relationship of these two "simply organized animals."

Holten authored a 179-page zoology of Denmark and Norway in 1800 and a description of shells in 1802. He was the curator of the Natural History Society's collections, which were transferred to the Royal Natural History Museum at his death (Henriksen 1923).

* * *

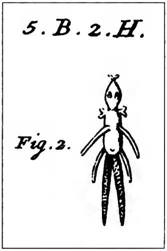
For a century after Linnaeus, species were described as if invariant and perfect examples of an "archetype" created in place at the dawn of time. The consequence of the lack of wide-area coverage was a collection of independent local faunas. Zoology, then, was typological and essentially nondimensional.

With the growing body of copepod literature came inevitable mistakes in understanding often inadequate descriptions; one can be less charitable about needless confusion, such as an author ignoring and replacing acknowledged senior names or not being consistent between his own publications.

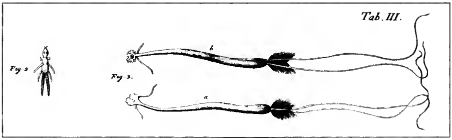
Altogether, up to 1800, about thirty-two valid copepod species had been described. This number is open to judgment regarding which described species might be synonyms and which might be recognizable today. The thirty-two species are a good cross section of the copepod taxonomic ranks: calanoids (five species), harpacticoids (three species), free-living cyclopoids (one species), and a commensal cyclopoid (one species), all assigned to the genus *Cyclops*; and parasitic cyclopoids (one species), poecilostomes (seven species), and siphonostomes (fourteen species), all marking time in the genera *Lernaea*, *Pennatula*, and *Caligus*.

Even though free-living copepods and the caligids had been brought together when Müller placed them in the new order Entomostraca, they and the other "crustaceans" only slowly found their own place outside of the overwhelming Class Insecta—which would not occur decisively until 1825. As for the puzzling zoophytes *Lernaea* and *Pennatula* that accounted for most parasitic copepods taken together as the eighteenth century ended, in a parallel twenty-five years before these two ends of the copepod spectrum were united, only a few bold or lucky workers even hinted at a relationship to the entomostracans.

Only after the first decades of the nineteenth century, as we will soon see, did there begin the gathering of information on various species with more exact observations, which formed the foundation of a brilliant period in the history of copepods that began with Nordmann (1832). Still, an attitude of medieval philosophy carried into the 1800s, and even beyond, when efforts focused strongly on texts and illustrations rather than on attempts to actually look at old or new specimens.



Lernaea merluccii *(Fig. 2) and* "Lernaea" exocoeti *(Fig. 3). From Holten (1802).*



9

A CELEBRATION OF CRUSTACEA

Then we got into a labyrinth, and, when we thought we were at the end, came out again at the beginning, having still to see as much as ever.

—PLATO, *Euthyphro*

THE APPROACH I have taken in this account is to imagine as best I can the state of knowledge of our predecessors during each period. Although tempted, I resisted reading the old volumes by candlelight, in the cold and damp, and going about daily chores on horseback. No doubt the best part of this practice would have been the absence of phone, fax, and e-mail, and their incessant appeals for immediate response. We take for granted and even malign instant communications, but it is important to remember that until the last half of the nineteenth century, mail systems were less than primitive. "A highwayman or a wench might delay the post" (Peattie 1938); exchanges of information, specimens, and—most important—publications were difficult, time-consuming, expensive, and hazardous.

In view of the rapid additions to the knowledge of copepods, especially the comparative studies anchoring them to their crustaceous place, it is not easy now to imagine oneself at the dawning of the nineteenth century as a physician or naturalist, wondering what to make of these ubiquitous testaceous insects or of the vermiform parasitic zoophytes. The examples mentioned illuminate this hazy period at the commencement of true copepodology.

New species and genera of copepods were being created frequently, mostly by entomologists; one could consider this an activity akin to piling bricks for a foundation and structure that was not yet designed. A broad classification that might provide a design could have been an artificial classification, selecting one character (habitat, for example, regardless of actual relationships), or a natural classification based on the greatest number of anatomical characters in common. Both natural and artificial systems were brought forward, and it would probably be impossible to consistently draw a line between the two. The various hierarchical terms—such as classes, orders, sections, tribes, divisions, and families—have never been absolutes from one era to the next, but they do serve well to indicate relative positions. As the nineteenth century opened, some scientists might have visualized the destruction of a Linnaean system

overwhelmed by new species. That this never happened is further testimony to the soundness of Linnaeus's concepts and his affinity toward genuine natural relationships. The eighteenth century's classification smoothly became the foundation for biology in the nineteenth century.

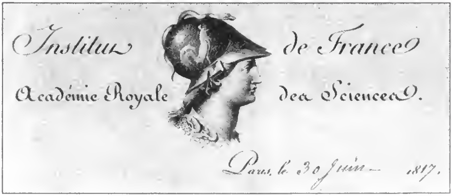
The transition from the eighteenth century to the nineteenth century in Europe was noted for its sharp social and political upheavals. Swept along with these radical changes, the various branches of science organized and advanced with a heretofore unseen objectivity. With regard to biology in general, and to the study of crustaceans in particular, the center of this activity was in Paris, at that time a zoological Mecca.

The period from the French Revolution in 1789 to the fall of Napoleon in 1814 (and again in 1815) responded negatively to the hard hand of war, but positively to the chords of general enlightenment. The Royal Academy of Sciences and the other royal academies were folded into the Institute of France during the Revolutionary era (1795) and divided into "Classes." The "First Class" of the institute was Mathematics and Physical Sciences, including natural history. The First Class, the scientific branch of the institute, therefore stood separately from medicine, agriculture, and the literature and arts components in the other classes. Membership in the institute was, as always, a treasured honor, beyond the mere lifetime salary. As always, membership depended on merit, personalities, politics, geography, and luck. In practice, the institute functioned as a government bureau. Many members had additional appointments (and salaries) elsewhere. Vacancies in the institute came about by death of a member, and thus predictions of openings were based on age structure of a section. A broad background enabled a candidate to enter via more than one section. The same membership rules held for eight prestigious foreign associate members and a hundred foreign corresponding members.

Napoleon himself became a member of the institute's First Class as a rising young general (with a few publications on political theory and artillery science). He continued to have an interest in the institute even after he became emperor with no time for meetings, although his interest sometimes was actual interference. Napoleon was undeniably an exceptional patron of science. In addition, his respect for science and scientists induced him to make several influential appointments from among their ranks (generally to his credit). The result was that French science, already on a good footing at the end of the eighteenth century, had a period of radiant growth under Napoleon. Eventually, however, the scientific focus turned in particular toward Germany in the mid-nineteenth century, following Germany's already strong standing in the humanities and literature.

Because of the amalgamation of learned disciplines in the institute, many scientists sought smaller specialized societies in which to hear, discuss, and publish their reports. There were many smaller societies, not only in Paris but in nearly every provincial city aspiring to greatness; today these societies and their published records give the librarian, bibliophile, and historian diverse mental contortions. One very popular association among naturalists was the Société Philomatique. This was begun in 1788 by four young physicians, one mathematician, and the eighteen-year-old mineralogist-to-be Alexandre Brongniart (see Chapter 13 for his relationship to Audouin). These men shared a passion for all forms of science, as well as a desire for increased knowledge, especially in natural history. The society published the *Bulletin des Sciences* from 1791.

During the period of suppression of the Royal Societies, and before the Institute of France was formed, the Société Philomatique was a refuge for many members of the royal appellations. This durably increased its prestige and further enhanced its membership. Probably the greatest value of the Société Philomatique was in providing young scientists a forum for experience and exposure. In this way it became a kind of training ground for the highest level, the Institute of France and its various sections. De Candolle (1862) called it simply "the nursery of the Academy of Sciences." Several members of the institute joined the society, even after the suppression of the academies, because of the soci-


Institut de France

Académie Royale des Sciences.

Paris, le 30 Juin 1817.

Georges Louis Leclerc de Buffon (1707–1788). From Delpech (1828). Courtesy of the University of Washington Libraries Special Collections.

Georges Louis Leclerc de Buffon (1707–1788). From de Beer (1948).

ety's regular meetings with younger scientists and, most importantly, its monthly bulletin.

Some of the demand for biological publication was met by the initiation of the *Annales* of the National Museum of Natural History in 1802. This, however, was essentially an in-house journal, printing the contributions of staff members. There were twenty volumes of Annales by 1813. After the Restoration, in 1815, a new series began. The First Class of the institute was renamed the Royal Academy of Sciences in 1816.

Before continuing with the history of the study of copepods, we will review the developing classification of Crustacea as a group ultimately independent of the other arthropods, particularly the insects.

Georges Louis Leclerc de Buffon

7 September 1707–16 April 1788

Very few historical figures can be termed "originals," since even the most forward-looking among them had precursors who molded or inspired their new thoughts. This is true as well of Georges Louis Leclerc de Buffon, probably the foremost theoretical biologist of the eighteenth century. However, Buffon is a convenient starting point for a tightknit group of savants who are all now considered among the champions of zoology and, although they had only a small role in the developing knowledge of copepods, warrant mention for their contributions to the emerging taxonomic foundation: Lamarck, Cuvier, and Latreille. To place this school in a historical context and continuity, we look first to Buffon, born in the same year as Linnaeus, but a scientist who pointed biology in entirely different directions.

Buffon was born in Burgundy, the son of a councillor of the provincial parliament in its capital at Dijon. Buffon was thus a member of the bureaucratic nobility, often renowned for their wealth and cultural interests. Buffon's early schooling was in law at the Jesuit school in Dijon. However, instead of following his family's career as expected, Buffon took an early interest in natural history while traveling in France and Italy. The last of his rewarding travels was to England, in 1738. Besides botany, Buffon also studied mathematics and physics (Miall 1912, Nordenskiold 1928).

Buffon first attracted the attention of science by translating several English research papers, while at the same time beginning independent studies. In 1739, he was elected an associate of the Royal Academy of Sciences and appointed as Keeper of the Jardin du Roi. This "Jardin," begun as a small medicinal-plant collection in 1626, became more than a garden; though it had languished for a century, under Buffon and his resources it became the center of biological research in France (Miall 1912).

Buffon knew society as well as science and was welcome as an added brilliance to the court of Louis XV. Through the force of his personality and accomplishments, he fashioned a general national interest for natural science. This interest included that of the king, usually indifferent to all other worthy pursuits, who provided generously for expansion of Buffon's garden and for its scientific work.

With the attention of royalty, Buffon was made a count and, in 1753, a full member of the academy. Buffon saw as his life work the creation of a general natural history, to include all that was known of nature. After ten years of work, Buffon, at age forty-two, published the first part of *Histoire Naturelle* in 1749; assisted by talented collaborators, he was to devote the rest of his life to it. Buffon's writing was exceptional, his descriptions were lively, and the whole work, in spite of the expense, became immensely popular. Of the thirty-six volumes published at the time of Buffon's death, approximately fifteen were attributed to him. Finally attaining forty-four volumes, although not reaching beyond zoology and geology, Buffon's *Histoire Naturelle* was long out of date when it ceased in 1804.

Buffon's great contribution to biology was the notion that since the universe responds to physical laws, so must the universe of living nature; moreover, these laws have worked on the earth and its life for a vastly long time. Under the real power of the Church, Buffon was forced to recant some of these heretical notions.

Buffon looked to the underlying phenomena of life, not just to collection of specimens. He criticized Linnaeus's classifications as profoundly unnatural and was pitiless in pointing out that crayfish could not be insects, nor mollusks worms. Buffon also recognized that there are only species (or even just individuals), and that the higher categories, though useful, are imaginary. Buffon did not live to address the invertebrates to the extent that he had dealt with the comparative anatomy of birds and mammals, so we must look to his immediate successors for advances in that field.

While Buffon's work was not propagated by some men of science, it was widely regarded by men of letters. As the first modern naturalist to point to natural barriers limiting the distribution of plants and animals, and to state that species are not permanent, he helped prepare the way for the incomparable work of Darwin (Singer 1959).

An amusing confrontation between Buffon and the U.S. Minister to France, Thomas Jefferson, was related by Goode (1901a). Jefferson, to dispel Buffon's widely accepted notion that New World animals are smaller than those of Eurasia, presented Buffon with a moose skeleton specially procured for the purpose. Buffon acknowledged his error and regretted that he had not previously consulted Jefferson, one of the true scientists of the new nation.

Although Buffon, the gentleman naturalist, had scoffed at the detailed work of his predecessor René Antoine Réaumur and had scorned Linnaeus's systems, near the end of his life the seemingly infinite features of the living world surprised and then dismayed him.

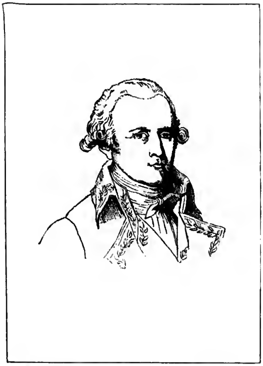
Productive to the last of his days, Buffon lived to see the weakening power of the Church when it was persecuted during the social revolutions, which allowed him to disavow his recantations. Buffon had hoped that his son, not so gifted as himself, would succeed him at his formal post in the Jardin. Buffon, dying in 1788, was spared the bloodlust of the Revolution and the execution of his aristocratic son.

Jean-Baptiste Lamarck

1 August 1744–18 December 1829

Jean-Baptiste Lamarck was a soldier turned physician turned botanist turned zoologist. Lamarck began his complex life in Picardy as the eleventh child of an impoverished noble family of soldiers, a marked contrast to the youthful situation of Buffon. Despite Lamarck's objections, his father enrolled him in the Jesuit college in Amiens. The father's death in 1760 removed this obstacle, and Lamarck, at seventeen, joined the common company of penniless soldiers. For bravery in action during the Seven Years' War with Prussia, Lamarck was given what we would today call a battlefield commission. The new officer was posted to Monaco, where, exposed to the sea, he became interested in natural history (Packard 1901, Landrieu 1909, Garrison 1914, Peattie 1938). An injury forced his retirement from the army in 1766, and after a few false starts in the civilian world, he looked toward the profession of medicine (Schmidt 1971).

The study of medicine in the eighteenth century afforded opportunities to explore all sciences, and Lamarck was especially attuned to chemistry, phys-



Jean-Baptiste Lamarck (1744–1829). From Packard (1901).

A. de Vaux-Bidon, del. *From an old engraving*

ics, and botany. He learned the latter subject during a nearly ten-year apprenticeship under Bernard de Jussieu. A practical, though non-Linnaean, three-volume "Flora of France" brought him notoriety and, with Buffon's blessing, membership in the Royal Academy of Sciences in 1779. From that time on he seldom missed a meeting. He was appointed to a royal commission to study the main herbariums of Europe, traveling for this purpose in 1781–1782 with Buffon's son, for whom he had been a tutor (Peattie 1938, Schmidt 1971).

From this time, Lamarck was associated with the Jardin du Roi where he was appointed to the Chair of Botany in 1788. After Buffon's death, Lamarck occupied Buffon's house on the garden grounds. The small group of savants, in the Garden of the King, watched heads rolling from lesser associations with royalty. Lamarck the botanist prudently had the name changed to its current "Jardin des Plantes," bringing immediate relief. Lamarck wrote a memoir to the National Assembly in 1790 outlining proposed changes to the administration. This led to the Muséum d'Histoire Naturelle in 1793–1794. Twelve new professorships were founded on the condition that lectures would be free. The first staff included Lamarck, the young Etienne Geoffroy Saint-Hilaire (1772–1844) (soon to be off with Napoleon to Egypt), and Buffon's careful anatomist Louis Jean Marie Daubenton (1716–1799) (Miall 1912, Cole 1944). Lamarck was a friend of Latreille and J. C. Fabricius. "All three were sympathetic and nonfanatical spirits" (Tuxen 1973).

Lamarck the botanist, at fifty, found himself appointed professor of all the zoology that nobody else wanted; that is, invertebrate zoology, a term that did not then exist. Lamarck, like most in the world, knew almost nothing of these zoological leftovers. We now know these to be by far the bulk of the animal world. At the end of his studies of these orphaned groups, he gave the first clear distinction between invertebrates and vertebrates, and he emerged with one of the significant concepts in history: all animals are connected in a series from the lowest to the highest, the latter of which is man. This revolution in science was all but overlooked against the background of Napoleon's wars (Peattie 1938, Schmidt 1971).

Lamarck's earliest work on invertebrates was the one-volume *Animaux sans Vertebres*, published in the Ninth Year of the Republic (1801) and addressed to "Citizens." He was the first to begin defining natural groups among the invertebrates, and his categories of echinoderms, annelids (which he segregated from the old Vermes), arachnids, and crustaceans are still recognized. Indeed, even the term "biology" was a Lamarck creation (Nordenskiold 1928, Singer 1959). Desmarest (1825) indicated correctly that Mathurin Jacques (also known as A. D.) Brisson (1723–1806) had been the first to separate a class "Crustaces" from the insects, in 1756 (Vervoort 1986a), but Brisson's class also contained the myriapods and arachnids, so his grasp of the relationships was not profound.[1] Lamarck retained Brisson's Class Crustaces as the second class of invertebrates (and the sixth in the animal kingdom); this included only crustaceans as we would recognize them today (except for the king crab), although, of course, it would be many years before the parasitic zoophyte copepods and the barnacles would be embraced. Thus, Lamarck was the first to remove crustaceans, and separately the arachnids, from the insects.[2]

After Lamarck's pioneering publication, most zoologists admitted the separate existence of a Class

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[1] Brisson, an ornithologist and physicist, was the curator of Réaumur's extensive cabinet (Miall 1912).

[2] Barnacles, to Lamarck, occupied their own group, in the farthest corner of the mollusks. Lamarck (1812) later placed the barnacles in a distinct class, the cirrhipedes.

Crustacea, although the change was slow to come in works of a general nature. Sue (1808), for example, still defined Entomostraca, monocles, *Amymone*, *Caligus*, *Cyclops*, and *Nauplius* as "insects." A brief outline of Lamarck's 1801 classification will serve to indicate the position of the free-living copepods (i.e., Cyclops) relative to the other crustaceans. Modern terms are indicated in brackets. French authors tended to use French-language terms, although most followed them immediately by the Latin equivalent. Within the Class Crustaces, Lamarck had two orders:

- Order 1. Crustaces pediocles (two distinct stalked eyes)
  - Section 1. [Including mostly crabs]
  - Section 2. [Including mostly shrimps and hermit crabs]
- Order 2. Crustaces sessiliocles (two distinct, or a single, sessile eyes)
  - Section 1. Including *Gammarus* [amphipod], *Oniscus* [isopod], and *Cyclops* (his example was *C. minutus* Müller)
  - Section 2. Including *Daphnia* [cladoceran], *Limulus* [xiphosuran], and *Amymone* Müller (Lamarck did not mention *Nauplius*)

The stalked- and sessile-eye terminology was popular for a century or more. Lamarck noted that Linnaeus had united nearly all the sessiliocles under the genus *Monoculus*, even though many have two distinct eyes. He also indicated that others had used for the sessiliocles an equivalent term, Entomostraca, and that the order spanned the forms between the pediocles and the arachnids.

Lamarck continued his fruitful studies of invertebrates—including fossil invertebrates—publishing many new papers that culminated in a second edition of *Animaux sans Vertebres*. This now required seven volumes and was published from 1815 to 1822. These were solid contributions to systematic zoology, earning Lamarck just comparisons with Linnaeus. He has been considered France's foremost "natural philosopher," as the profession was then called (Nordenskiold 1928). His contributions to copepod research were commemorated in the name *Caligodes lamarcki*, given by Quidor (1913).

Lamarck's new crustacean classification, introduced in Volume 5 in 1818 (Vervoort 1986b), presented many now familiar terms, and the examples of genera reflected the growing body of knowledge of copepods:

Jean-Baptiste Lamarck (1744–1829). From Packard (1901).

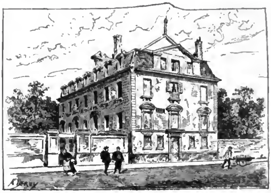
- Order 1. Heterobranches
  - Section 1. Branchipodes (containing 4 groups)
    - a. Franges (including *Cyclops, Cypris* [ostracod], *Daphnia*, and *Zoea* [a decapod larval stage])
    - b. Lamellipedes [mostly branchiopods]
    - c. Parasites (including [copepods] *Dichelesthium*, *Cecrops*, and *Caligus*, as well as *Argulus* [branchiuran])
    - d. Geans (including *Limulus*)
  - Section 2. Isopodes
  - Section 3. Amphipodes
  - Section 4. Stomapodes
- Order 2. Homobranches
  - Section 1. Macroures
  - Section 2. Brachyures

Lamarck (1801) placed the lernaeids in the class of mollusks, under the order Mollusques cephales, section Nus, along with cephalopods and pelagic gastropods, all of which "swim slightly in the water." He recorded *Lernaea branchialis*, which he wrongly equated to Müller's *L. gadina*. Lamarck placed *Pennatula* within the Class Radiares, but his only example was a coelenterate.

In a later scheme, from 1809, Lamarck had the lernaeids with the annelids, next to the leeches (de Blainville 1822a, Wilson 1917a). A few years later,

Paris ce 5 pluviose an dix
Lamarck

Jean-Baptiste Lamarck (1744–1829) in the costume of a member of the Academy of Sciences, 1802. Portrait from Landrieu (1909); signature from Packard (1901).



Drawn by A. Deroy, 1886

Buffon's house in the Jardin des Plantes, where Lamarck lived from 1793 to 1829. From Packard (1901).

Lamarck (1812) assigned the lernaeids to a separate group of worms, the Epizoaires (Epizoaria), "between the insects and the [other] worms," and in this fashion brought them closer to our perception. Lamarck's only epizoarians were *Lernaea* and *Chondracanthus* (copepods) and *Bopyrus* and *Oniscus* (isopods); he added that perhaps these external parasites should be in a distinct class. By 1816, the Epizoaria indeed formed a class of their own (Wilson 1917a). Johnston (1847) admitted that Lamarck had not made the zoophytes any better: "As a systematist, however, Lamarck has few equals, and probably, with the exception of Linnaeus, not a superior."

Unfortunately, Lamarck is remembered most for his discredited theory of the inheritance of acquired characters. What is overlooked in this regard was Lamarck's bold assertion of evolution. Even though his hypothesis was wrong, Lamarck was breaking new and dangerous ground with these ideas. Had Lamarck recognized the cruel mechanism of natural selection, he may have taken fifty years off the quest for the origin of species. Lamarck was not far from the impact made by Darwin.

In 1825, Latreille requested that he be allowed to replace Lamarck in his teaching duties because of the latter's failing eyesight—paying the price for years of work with poor microscopes and bad light. The next year, Bosc replaced Lamarck. Lamarck died in 1829, in his eighty-fifth year, having served under the monarchy, the republic, the empire, and the monarchy again.

We will soon be discussing another cosmopolitan giant of zoology, Cuvier. Lamarck was Cuvier's senior colleague at the National Museum of Natural History. Lamarck had a better understanding and better arrangement of invertebrates than did Cuvier, but Cuvier's personality, though ultimately not his work, overshadowed all others. "Lamarck seemed to have a talent for getting his work ignored" (Winsor 1976b). On the other hand, Cuvier had a talent for suppressing the work of his colleagues, doubly dangerous because he passed as their friend.

> It would be a blow . . . for Cuvier if he could see where Lamarck stands today. Cuvier, who knew a thousand facts, was the author of the worst theory of the history of life that was ever suggested by a great scientist. The true explanation—or the most nearly true—began with Lamarck as an intuition, became a conviction, and, unsupported by proofs such as we could give today, went down in apparent defeat. No one fails so completely as a genius.

> Lamarck was the type of odd, nervous, gentle gentleman who closes the door so that no one shall see that he is sharpening his own pencil. As he never barked, people supposed that he had no teeth to bite with. He lacked a nose for advantageous turnings to take in his life; he was as reckless of personal interest as he had been of his life on the battlefield. He was so faithful to his duties as a keeper . . . that the institution could really not

> have afforded to part with him. . . . Least of all would it recognize that the boldest and the noblest intellect amongst them resided in the long, narrow head with the thinning hairs that was seen sometimes at the third-story window of the old house. . . . A tall old man standing there to feel the sunlight that he could not see. . . . Lamarck was not laid away in a permanent plot; there was no money for such a luxury. His lodging was his for five years only. . . . Today the site of his resting place is obliterated. . . . There is not an inch left for a monument to honor him, however modest or small. (Peattie 1938)

At Lamarck's funeral, Cuvier's well-known but regrettable eulogy of his colleague, damning with faint praise and satiric courtesy, contrasted with the truly kind words of Latreille and Geoffroy. Outweighed by Cuvier in life and long afterward, Lamarck has been the final victor. As his daughter said at his funeral: "Posterity will honor you."

Georges Léopold Chrétien Frédéric Dagobert Cuvier

23 August 1769–13 May 1832

Georges Cuvier was born in Montbeliard, France, in the same year as Napoleon, Wellington, and Humboldt—and James Watt's first steam engine. Montbeliard is not far from Basel, Switzerland, and though French it was then in the Duchy of Württemberg. Cuvier was attracted to natural history early on from reading Buffon. He easily passed with youthful honors through the local schools. His father was a retired army officer of meager resources, unable to offer his bright son special educational opportunities. Chance provided what the father could not, by way of free entry to the renown civil-service Karlsschule at Stuttgart, at the center of Württemberg.[3] There, under the umbrella of agriculture and forestry, Cuvier was formally and favorably introduced to natural science (Nordenskiold 1928, Peattie 1938).

After graduation, in 1788, the year of Buffon's death, Cuvier found a position as a tutor to a noble family on the Normandy coast, where he enthusiastically took up the study of marine animals and passed the terrible years of the Revolution in relative tranquility and isolation. Cuvier was particularly intrigued by mollusks, worms, starfish, and jellyfish, and quickly found that the standard Linnaeus did not treat them adequately. In fact, Cuvier found a greater satisfaction with Aristotle's writings. Cuvier, a skilled draftsman, illustrated everything he studied; some of these drawings found their way to the Jardin des Plantes, where they impressed the new professor Geoffroy (Cap 1854).

Georges Cuvier (1769–1832). From Pilleri and Arvy (1981); signature from 9 June 1806, Document 22001, Museum of Natural History, Le Havre.

Called to the Jardin des Plantes in 1795, Cuvier brought to the philosophizing French the technical skill of the German anatomists. In 1800, Cuvier was recommended to a professorship in natural history by Geoffroy, who was at first Cuvier's patron, then rival, then archenemy (Nordenskiold 1928). This seemed to be a pattern in Cuvier's life. He was amiable and helpful to those he considered beneath him, but he could not abide any who came close to his own growing stature. In 1802, he was appointed Professor of Comparative Anatomy at the museum. Cuvier became the "dictator of biology"; a word from him would make or break a career, and there were many examples of each:

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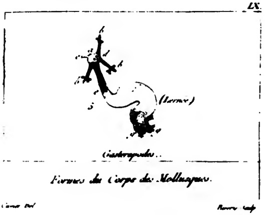
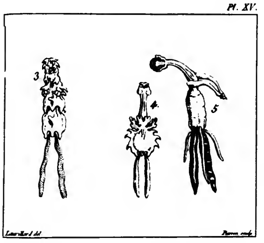
[3] The poet Schiller had been a pupil at Karlsschule.

> But there sat at Lamarck's table, strolled in and out of his office, borrowed his authority and his pencils, one who resented the whole notion that the living world was not a rigid and immutable exhibition intended as material for the profoundly interesting subject of comparative anatomy. One who, consciously or not, could only work and be agreeable if he were captain of the game. His name first appears in the acts and memoirs of the Museum when in 1795 Lamarck arose to second a proposition that a young Monsieur Cuvier be invited to leave his jellyfish on the Normandy shore and come to the Jardin des Plantes to pursue his anatomical studies where his confreres might further and enjoy them. (Peattie 1938)

After the museum professorship, for which he was not yet truly qualified, Cuvier advanced quickly, receiving many honors and promotions. Energy, accomplishments, organizational skills, and a handsome appearance made Cuvier a favorite in the emperor's court. Alongside his professor's duties, he was assigned important functions in the state educational system.


IX.
(Lernée)
Gastéropodes..
Formes du Corps des Mollusques.



A lernaeid, considered at this time to be a gastropod mollusk (from Cuvier 1798, Pl. IX–upper). Three "lernaeids," Delaroche's chondracanthid (Fig. 3), a species from a gurnard (Fig. 4), and another from a tuna (Fig. 5), considered at this time to be intestinal worms. From Cuvier (1817a), Pl. XV–lower.

Even after Napoleon's fall, Cuvier's undisputed talents kept him in his place, with still more acclaim. He was made a baron and a minister within the new government. Eventually he became a peer of France. Cuvier died of cholera, during its first European epidemic, in 1832 (Nordenskiold 1928).

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Other comparative anatomists had been trained as physicians, and thus had man as the primary element. Cuvier, in contrast, began at the opposite end of the animal scale. His life's mission, unfulfilled, was to compile a general comparative anatomy; he often referred to this grand plan within his many shorter publications.

Cuvier published well over two hundred separate works (Agassiz 1850). An early translation of Pliny's "Natural History" may have encouraged Cuvier's larger scientific plans, although it was in his time fashionable to ambitiously encompass all knowledge in "dictionaries" and "encyclopedias." In Cuvier's own 1817 four-volume *Le Règne Animal*, he covered the fields of vertebrate and invertebrate comparative anatomy, classification, paleontology, and geology.[4] This impressive outcome of twenty years of research was the most comprehensive biological work of the period. In it, Cuvier described at least one species from nearly every known genus. His "Animal Kingdom" had a second edition, of five volumes, in 1829–1830 (Vervoort 1986a). Both editions were translated into German and English and were enormously influential for a long time. They made Cuvier the founder of comparative zoology and of vertebrate paleontology (Tuxen 1973). Cuvier stood across the entire field of zoology; no one else came close.

Cuvier explained that fossils had come about through a succession of earth catastrophes, after which animals of a different kind spread out from isolated refugia. Recent ideas have come around a bit to his way of thinking. But within Cuvier's theory was the unyielding belief in the immutability of species; he was also the mortal enemy of all who would arrange animals in one series.

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[4] The crustaceans, as they were known then, were dealt with primarily by Latreille and will be reviewed with his contributions.

Cuvier's idea was to have classification mirror anatomical structure, not just a few external characters that might not even have real importance. To Cuvier, there were four main and unrelated groups: Vertebrata, Articulata, Mollusca (including barnacles), and Radiata (his term for Zoophytes). Cuvier designated a special relationship between the arthropods (insects, crustaceans, and relatives) and the annelids (segmented worms) by combining them under the Articulata. Within these four groups, but never between, comparisons could be made. Paradoxically, Cuvier's arrangement was more amenable to later evolutionary thinking than was the single-series notion of Lamarck.

The term "invertebrates" was Cuvier's, and it was immediately ratified by Lamarck and others. Cuvier coauthored papers with the other great biologists mentioned in our context: Lamarck, Geoffroy, and Latreille.

Cuvier's arrangement of crustaceans was not as well developed as that of his contemporaries, and he soon deferred to them. In the Sixth Year of the Republic, Cuvier (1798) published an "Elemental Table of the Natural History of Animals" in which crustaceans were still ranged within the insects (see also Desmarest 1825):

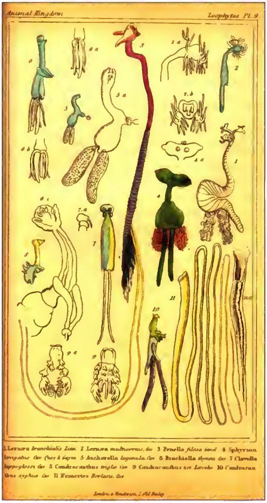
Insectes A. With many pairs of jaws

1. Monoculus (included *Cyclops, Caligus, Nauplius,* and *Amymone* of Müller)
2. Cancer (included *Cancer* and other higher crustaceans)
3. Oniscus [included *Oniscus* and other isopods]

In 1799, Cuvier and his pupil A.M.C. Duméril (addressed in the next chapter) made a few changes to this scheme by combining Monoculus and Cancer under "Crustaces," separate from the insects although the category Oniscus remained within the insects.

Cuvier (1798) placed the lernaeids first under the gastropods in the Mollusca. Here was described *Lernaea branchialis,* with a fairly good figure credited to Cuvier himself. Cuvier added that "one finds, on gills of many fishes, parasitic animals which naturalists have taken to be lernaeids, but which are closer to insects, especially to *Monoculus,*" by which he undoubtedly meant in particular *Caligus.*

After twenty years, Cuvier's (1817a) treatment of the lernaeids still reflected the ambiguity expressed on all sides. He then had moved them from the mollusks to another "Grande Division" of animals, the Zoophyta, to its Second Class Entozoa, the intestinal worms. He listed three species of *Lernaea* from literature, noting again that many species had been wrongly placed in this genus. Even though they were also found on fish gills, the others had articulated bodies, antennae, mandibles, and legs, and were therefore (now!) crustaceans. Other species of zoophyte copepods were "various chondracanthids," three forms of which were illustrated by Charles Laurillard (1783–1853), Cuvier's draftsman, secretary, and friend of thirty years (Sarjeant 1980): the chondracanthid of Delaroche (in Cuvier's Fig. 3),


Animal Kingdom
Zoophytes Pl. 9
1 Lernæa branchialis Linn. 2 Lernæa multicornis. Cuv 3 Penella filosa Lamk 4 Sphyrion lævigatus Cuv (Quoy & Gaym) 5 Anchorella lagenula. Cuv 6 Brachiella thynni Cuv 7 Clavella hippoglossi Cuv 8 Condracanthus triglæ Cuv 9 Condracanthus zei Laroche 10 Condracanthus xyphiæ Cuv 11 Nemertes Borlasii. Cuv
London, Henderson, 2 Old Bailey

Some "zoophytes" from the London edition of Cuvier's Animal Kingdom. *From Cuvier (1837).*

and two then-nameless others that "stood near to *Caligus*," but which Cuvier believed nonetheless were lernaeids, one species from a gurnard (Cuvier's Fig. 4) and one species from a tuna (his Fig. 5). Under Cuvier's strong personality and influence, his taxonomic stand on lernaeids and his rejection of crustacean metamorphosis likely retarded the acceptance of the facts as revealed in 1819 (see Chapter 13).

By 1830 and the second edition of Règne Animal (Vervoort 1986a), knowledge of zoophytes (the same as Cuvier's Radiata) remained too imperfect for serious revision; that group was still a catchall of organisms with radial plan. The zoophytes contained five classes, the fourth of which was "Polypes," the accepted category for most "true" zoophytes for many years afterward. But to the credit of Cuvier's circle, at least the zoophytes were animals. Remaining in the Polyps was Pennatula, still next to sponges as in earlier systems, including what today are acceptable coelenterates, but also including the copepods of the subsequent genus Pennella. A related genus, Sphyrion, was established by Cuvier in the 1830 edition (Kabata 1979).

Cuvier split the lernaeids into several groups, which would be seen today as haphazardly mixed (Kabata 1979). He included several species that would not now be classed with the lernaeids as cyclopoids, but with the siphonostomes, such as his own genus and species *Brachiella thynni*, the first modern description of the presumed Aristotelian copepod, and Cuvier's species *Clavella* (now *Hatschekia*) *hippoglossi*. It must be remembered that by 1830, several other workers, in particular de Blainville (1822a) and Desmarest (1825), had reappraised the lernaeids (in the broad sense) and shifted them toward the crustaceans, so that Cuvier was not entirely on new ground, a fact that he acknowledged.

The London edition of Cuvier (1837) (there was also an American edition in 1831) included illustrations of the old species *Chondracanthus zei*, *Lernaea branchialis*, and *Pennella filosa*. Illustrated species attributed to Cuvier were *Anchorella lagenula* (in a Cuvier genus from 1830, a synonym of *Clavella* Oken, 1816), *Brachiella thynni*, *Chondracanthus triglae*, *C. xyphiae*, *Clavella hippoglossi*, *Lernaea multicornis*, and *Sphyrion laevigatus*.

The Zoophyta, or Radiata, persisted as a catchall group for mostly lower invertebrates. Because of Cuvier's authority, changes in the zoophyte category proceeded slowly. J. V. Thompson, whom we will meet in the copepod narrative in 1829, established the Class Polyzoa in 1830 out of the old broad Zoophyta, but Thompson's was an obscure work, so Ehrenberg's "Bryozoa" of 1834 is what we remember. We will see how the parasitic copepods were finally taken from the zoophytes in the 1830s. Another notable change was made in 1848 when Rudolf Leuckart, an important presence in the study of copepods, characterized the basic differences between coelenterates and echinoderms, both from Cuvier's Radiata. Soon after mid-century, zoophytes as a component of animal classification ceased to exist (Baird 1863).

This may be the proper place to mention the fate of tunicates, up to this time also imprisoned either in the zoophytes or mollusks. Tunicates were mentioned in Chapter 3 with the copepod found by Redi (1684). They will be mentioned again when the important group of tunicate-dwelling copepods, the notodelphyids, is established. Lamarck recognized the tunicates as a major division, although Cuvier retained them as radiates. The renowned Leuckart believed they were mollusks. It was not until 1871, when Aleksandr Kovalevski (1840–1901), through embryological research, demonstrated the surprising affinity of tunicates with vertebrates (Dawydoff 1928).

* * *

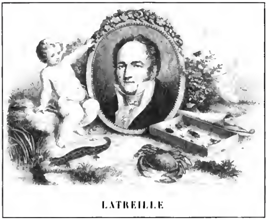
While Cuvier became increasingly convinced that species in their rigid basic groups did not change, Geoffroy became equally convinced in the close and fluid relationships between all animals. In their own ways, both contributed to the modern ideas of evolution. Cuvier's ideas generally retarded evolutionary views, until the last of his influential followers died out in the closing quarter of the nineteenth century (Singer 1959).

Pierre André Latreille

29 November 1762–6 February 1833

The phrase "Swammerdam, Linnaeus, Fabricius, and . . . " is brought well into the nineteenth century by the appropriate addition of "Latreille." In fact, Fabricius himself passed the mantle of greatness to his colleague and friend Latreille (Geoffroy 1833), just as it had been given by Linnaeus to Fabricius, and Latreille dominated the following generation (Tuxen 1973, Dupuis 1974).

Pierre André Latreille was born in the small town of Brive, in the Limousin province, not far from the famed porcelain town of Limoges in central France. His parents were descendants of an honor-



Pierre Andre Latreille (1762–1833). From Cap (1854).

Fontaine de la rue Cuvier

Fountain on the Rue Cuvier. From Cap (1854).

able family, but Latreille was orphaned at an early age and thus deprived of material resources. His gentle disposition brought him substantial protectors, first a physician and soon afterward a merchant from Brive. The latter encouraged Latreille's inherent attraction to natural history by providing books and instruction (Jardine 1837).

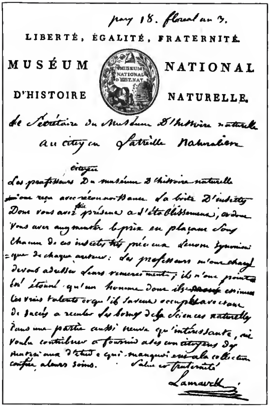
Another early patron was the governor of the Paris hospital, a baron, who brought Latreille to Paris in 1778. This kind man soon died, but his place in Latreille's life was generously taken by the baron's family. Through their influence, Latreille was placed in the college of Cardinal-Lemoine, where he was befriended by the abbot, the noted mineralogist and professor René-Just Haüy (1743–1822). During this time, Latreille became devoted to the study of insects and began records and manuscripts that were published as early as 1792 (Jardine 1837, Cap 1854).

At the completion of his literary studies, about 1786, his guardians proposed that he enter religious service, a natural conclusion to his formal education. This step, to which Latreille agreed, ultimately exposed him to the utmost persecution and peril, which could not have been foreseen.

Latreille happily divided his time between entomologizing in the country and Paris, where in 1788 he formed friendships with a number of naturalists, including Fabricius, Bosc, and Lamarck. Lamarck's relationship with Latreille became so cordial and lasting that Latreille called Lamarck his adopted father. In 1791, Latreille was elected a corresponding member of the Natural History Society of Paris, followed shortly by a similar connection to the Linnean Society of London (Jardine 1837).

In 1793, at the height of revolutionary and counterrevolutionary excesses, Latreille, regarded as a member of the ecclesiastical class, was arrested in Brive by agents of the Revolutionary Tribunal. He was taken to the dungeons of Bordeaux and, with seventy-three other unfortunates, condemned to deportation. All knew that this meant never to see France again and certain death in a far-off, ghastly penal colony (Geoffroy 1833).

After a prolonged and hopeless incarceration, the day came when the prison physician decided to inspect the unfortunates. At that moment, Latreille was preoccupied with a strange beetle scuttling over the floor of his small dungeon cell. The physician was startled to see this unusual behavior in a man under such a sentence and assumed that he had gone past the limits of reason. When questioned, Latreille responded: "It is a very rare insect!" The physician, duly impressed, took up the proffered treasure and delivered it to an aspiring young local naturalist of his acquaintance, the fifteen-year-old Bory de Saint Vincent. The youth, already knowing Latreille by his earliest publications, was intensely flattered.



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LIBERTÉ, ÉGALITÉ, FRATERNITÉ.

MUSÉUM NATIONAL D'HISTOIRE NATURELLE.

Le Secrétaire du Muséum d'histoire naturelle

au citoyen Latreille Naturaliste

Lamarck

Letter from Lamarck to Latreille, 8 May 1795. From Landrieu (1909).

He was, apparently, also well connected, for he was able to obtain Latreille's (and a cell mate's) release. Within a month, all the other condemned men were dead from a notorious killing frenzy that overtook the Gironde region, a hotbed of counterrevolutionary action (Cap 1854).

Latreille later named the insect that saved his life *Necrobia ruficollis*; as the name implies, it lives upon the dead. It is one of the strange contradictions of nature that this red-collared eater-of-corpses gave life to him who would one day be the prince of entomology.

Many entomologists who followed Latreille knew about this miraculous deliverance and gave *Necrobia ruficollis* pride of place in their insect cabinets. A fortunate few had a special memorial: a notation in Latreille's own hand testifying that this beetle from Bordeaux was a gift from the master (Geoffroy 1833).

I cannot go back to the main thread of Latreille's story without remarking here on an extraordinary, similar, and related coincidence. Latreille's association with the mineralogist-professor Haüy was noted above. Another student of Haüy's at Cardinal-Lemoine was the often-mentioned naturalist Etienne Geoffroy Saint-Hilaire, whose family by that time had provided three members to the exalted Academy of Sciences. In 1792, a mob of hysterical revolutionaries attacked the college church and began an infamous massacre of priests and scholars. Haüy and some others took refuge on an upper floor, where they could only witness the approach of barbarous deeds. Geoffroy, at the Jardin, heard of their plight and threw himself into harm's way, protecting his friend and professor at the risk of his own life. After many long hours of protracted bravery, Geoffroy was able to save the surviving captives, including Haüy. Haüy later joined the Jardin scholars as Professor of Mineralogy at the Muséum d'Histoire Naturelle and is best known today as the founder of the science of crystallography (Cap 1854).

After Latreille's close brush with death, he understandably remained far away from any political/social focus. He found his life's expression in natural history. In 1795, he sent a fine, labeled collection of insects to the National Museum. In acknowledgment, Lamarck recorded the museum's official gratitude on 8 May:

> 18 floreal an 3
>
> The Secretary of the Museum of Natural History
> To Citizen Latreille, naturalist
>
> The professors of the Museum of Natural History have received with thanks the box of insects that you have given to the establishment, and of course you have increased the value placed on each of these very precious insects [by] the synonyms for each author. The professors have asked me to convey their thanks to you; they have not at all been astonished that a man, according to their esteem, of genuine talents, and who they know is occupied with all success in extending the boundaries in one part of natural sciences, also finds that it is of interest, that he wishes to contribute to provide to the fellow-citizens the materials of study that are lacking in the country's collection in their care.
>
> Greetings and brotherhood,
> Lamarck.

Events suggest that this letter (facsimile in Landrieu 1909) may have been more than a politically correct, though cordial, recognition of a meaningful gift.

Knowing Lamarck's sympathies for rising young stars, this note may have been an early maneuver toward Latreille's employment at the museum.

Politics-run-amok did not abandon Latreille entirely. In 1797, he was accused of being a fugitive (which perhaps technically he was); by that time, however, Latreille had powerful friends, including a general, a judge, and a small army of professors. In 1798, Latreille moved permanently to Paris and soon was named a corresponding member of the Institute of France, the organization that embraced all of the professional academies; supported by Lamarck, Geoffroy, Cuvier, and others, he was employed in the National Museum of Natural History to arrange the collections of insects.

Latreille's first major expression of crustacean classification was in 1796 in a large work titled *Précis des Caractères génériques des Insectes* (Desmarest 1825, Vervoort 1986b). This system followed Müller's of 1785, keeping all the entomostracans, as well as the higher crustaceans, within the Insecta aptera:

- Insectes
  - Division 2. Apteres
    - Class 12. Entomostraces
      - Family 1. Monocles
        - 1. Univalves (including *Amymone* and *Nauplius*)
        - 2. Bivalves [including cladocerans and ostracods]
        - 3. Crustaces (including *Cyclops*)
      - Family 2. Binocles
        - 1. Univalves (including *Argulus* and *Caligus*)
        - 2. Bivalves [other cladocerans]
    - Class 13. Crustaces [including amphipods and higher crustaceans]
    - Class 14. Myriapodes (including *Oniscus* [and other isopods])

In 1802–1805, the system moved much closer to Lamarck's pioneering classification of 1801, in Latreille's fourteen-volume *Histoire naturelle générale et particulière des Crustacés et des Insectes* (Desmarest 1825, Agassiz 1853), except that some isopods were retained as insects:

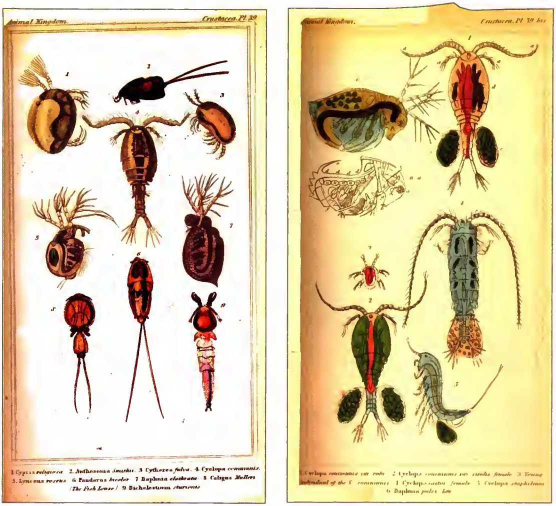
- Class Crustaces
  - Subclass 1. Entomostraces
    - Section 1. Opercules
      - Order 1. Xiphosures (*Limulus*)
      - Order 2. Pneumonures (*Caligus, Binoculus*)
      - Order 3. Phyllopodes (*Apus*) [branchiopods]
      - Order 4. Ostracodes (*Daphnia, Cypris*)
    - Section 2. Nus
      - Order 5. Pseudopodes (*Cyclops, Argulus*)
      - Order 6. Cephalotes (*Polyphemus, Zoea, Branchiopoda*)
  - Subclass 2. Malacostraces
    - Order 1. Decapodes
      - Section 1. Brachyures
      - Section 2. Macroures
    - Order 2. Branchiogastres (including *Mysis, Gammarus,* and *Phronima*)
- Class Insecta
  - Subclass 1. Tetraceres [most isopods]

Note that *Binoculus*, usually considered a synonym of *Argulus*, was sometimes a synonym of *Caligus*. *Argulus*, here in the same order with *Cyclops*, was considered a copepod for more than a century, but it is now kept in a separate taxon.

Latreille's greatest contribution was to review all known insects; by grouping them according to a natural classification, he arranged all the genera into families. This work, which fixed his fame as the foremost entomologist, was the four-volume *Genera Crustaceorum et Insectorum*, from 1806–1809 (Agassiz 1853, Vervoort 1986b). The classification of crustaceans was essentially that of Latreille's 1802–1805 effort (Desmarest 1825).

The great mass of facts from the 1806–1809 volumes was summarized by Latreille (1810) in his *Considérations générales. . . .* Latreille dedicated this book to Cuvier, "who has honored me with his kindness every day for the last 15 years." The first section briefly reviews the background of natural history and classification from the time of "the immortal Linnaeus." The second part introduces the classification, with brief descriptions of each taxon down to genus, followed by synonyms. Myriapods were now a separate order of arachnids, although some isopods remained in an adjacent order. The classification of crustaceans was not a particular improvement on the previous system:

- Order 1. Entomostraces. Entomostraca
  - Family 1. Clypeaces (including *Limulus, Caligus,* and *Argulus*)
  - Family 2. Ostracodes


Animal Kingdom.
Crustacea. Pl. 39
1 Cypris religiosa 2. Anthosoma Smithii 3 Cytherea fulva. 4. Cyclops communis.
5. Lynceus roseus 6 Pandarus bicolor 7 Daphnia clathrata 8 Caligus Mulleri
(The Fish Louse) 9 Dichelestium sturionis
Animal Kingdom.
Crustacea. Pl. 39 bis
6 Daphnia pulex

Various "Monocles" (Entomostraca) from the London edition of Cuvier's Animal Kingdom. *From Cuvier (1837).*

    Family 3. Gymnotes (including *Cyclops*, *Zoea*, and Branchipodes [cladocerans])
  Order 2. Malacostraces. Malacostraca

In 1817, Latreille persisted in improving his classification and holding crustaceans up to public acclaim with his contribution to the third volume of the first edition of Cuvier's *Le Règne Animal* (Vervoort 1986a). With its attachment to this influential publication, together with its undoubted appeal, Latreille's final classification was incorporated into most of the crustacean literature for over half a century. Since Latreille was concurrently the editor of the insect and crustacean sections of the monumental *Dictionnaire des Sciences Naturelles*, he was able to incorporate names of genera "communicated by Leach." In having the "genera correspond to the system of Leach," Latreille's use of *Calanus*, at least, predated Leach's establishment of this famous copepod genus by two years. Latreille's system was outlined by Desmarest (1825):

- Class Crustaces
  - Order Decapoda
    - Family Brachyures
    - Family Macroures
  - Order Stomatopodes
  - Order Amphipodes
  - Order Isopodes
  - Order Branchiopodes (or Monocles)
    - Section Poecilopes or Paecilopes [both

spellings used] (including *Anthosoma, Cecrops, Pandarus, Nogaus,* and *Risculus* [of Leach], *Dichelesthium* [of Hermann], *Argulus, Caligus*)
Section Phyllopes (including *Artemia, Binoculus*)
Section Lophyropes (including *Cyclops, Calanus, Daphnia, Cypris*)

Latreille's work was included in Cuvier's second edition of 1829 (Agassiz 1853, Vervoort 1986a), in which Latreille described the second genus, *Dinemoura*, of the copepod family Pandaridae (Kabata 1979). I have not had access to the original French edition, but the classification in the American edition (Cuvier 1831) seems to utilize the best parts of that given by Latreille in 1810 and 1817:

- Class Crustacea
  - Division 1. Malacostraca
  - Division 2. Entomostraca
    - Order 1. Branchiopoda
      - Section 1. Lophyropa
        - Group 1. Carcinoida (including *Cyclops, Calanus, Pontia* Milne Edwards, 1828)
        - Group 2. Ostracoda
        - Group 3. Cladocera
      - Section 2. Phyllopa
    - Order 2. Paecilopoda
      - Family 1. Xyphosura
      - Family 2. Siphonostoma
        - Tribe 1. Caligides (including *Argulus, Caligus, Nogaus, Pandarus, Dinemoura* Latreille, *Anthosoma, Cecrops*)
        - Tribe 2. Lerneiformes (including *Dichelesthium, Nicothoe* Audouin & Milne Edwards, 1826)

Even though the copepods recognized as crustaceans by Latreille were still widely separated within the Entomostraca, the pieces were slowly coming together. This is especially evident with Latreille's Tribe Lerneiformes, "which approximate to the Lerneae, in their external configuration, still more than the preceding [Caligides]" (Cuvier 1831). Even though the lernaeid specialist of 1830 might have known about Suriray's proofs, de Blainville's equivocations, and Desmarest's last-minute conclusions, it would be some time before the comprehensive zoological works, like Cuvier/Latreille, incorporated this knowledge.

Pierre Andre Latreille (1762–1833). From Jardine (1837).

The crustacean section of the London edition of Cuvier (1837) was also attributed to Latreille and illustrated a number of copepods, some of which, such as *Pontia* and *Nicothoe* above, we have not yet encountered in this narrative: *Anthosoma smithi, Cyclops communis, C. communis var. rubens, C. communis var. viridis,* "young individual" (nauplius) of *C. communis, C. castor, C. staphilinus, Pandarus bicolor, Caligus mulleri,* and *Dichelesthium sturionis.*

In spite of his extraordinary output, Latreille, modest and absorbed in his work, remained thirty years at the National Museum of Natural History in a relatively low position. Of his work, "he explored it as a connoisseur, studied like a Benedictine monk, and described as a poet" (Howard 1930).

The lists of publications from 1792 to 1834, inserted in Jardine (1837) and Agassiz (1853), probably account for most of Latreille's printed works. There are several papers dealing with the natural history of apes, reptiles, and salamanders, as well as with scientific views of ancient empires. Vervoort (1986b) listed seven publications appropriate to copepod research.

Latreille's was the first name to be sanctioned and admitted to the Royal Academy of Sciences by Louis XVIII upon his 1814 return to France and to a short-lived first new kingdom before Napoleon's brief return. Latreille was an honorary member of most of the natural history societies of Europe. He was elevated to the Legion of Honor by the king in 1821, but he did not achieve the position he regarded as most desirable, a professorship in the National Museum of Natural History, until 1827. This was the only Chair of Entomology in Europe, and Latreille was the first to fill it (Cap 1854, Howard 1930); he was "venerated by zoologists of all countries as the supreme legislator of entomology" (Geoffroy 1833).

Upon Lamarck's death, Latreille occupied the house that had been Buffon's. Latreille had been several years a widower; childless, he was cared for in old age by a niece whom he adopted. Latreille worked on manuscripts while bedridden prior to his death on 6 February 1833 (Geoffroy 1833).

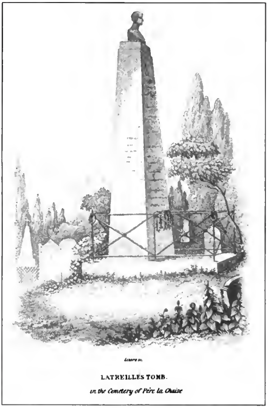
Near the end, Latreille was elected under the warmest circumstances as the Honorary President of the Entomological Society of France. On 8 February 1833, the society guided a majestic funeral attended by representatives of the principal societies and administrations, including Geoffroy (President of the Royal Academy of Sciences), who gave a eulogy; Audouin (of the Entomological Society), who gave another eulogy; de Blainville; and "an immense concourse of naturalists and men of learning and science" (Jardine 1837). Especially mentioned was Bory de Saint Vincent, "today our fellow-member" (Geoffroy 1833), who was most likely present; we will meet him in a copepod context from 1826.

> Although all of you know that Latreille was one of the most eminent men whom study has formed, you are not all aware that he was likewise one of the best whom Nature has made. Let one who has had the happiness to enjoy his friendship for the period of nearly forty years be permitted to pass upon him that simple eulogy. It would, I am certain, be more satisfying to his heart than all those called forth by his genius or talent. (President of the Entomological Society, qtd. in Jardine 1837)

> Adieu, my learned and virtuous associate! adieu, the oldest of my friends! (Geoffroy 1833)

The Entomological Society was determined to erect a monument over Latreille's tomb, and this, by subscription, was completed in 1835. A nine-foot obelisk of polished native stone, inscribed with his honors and major publications, arises from a base of the same and was crowned with a bronze bust of Latreille. The monument holds a double box of lead containing papers appropriate to Latreille's life (Jardine 1837). A final fitting touch is the Latin engraving, on the base, of "*Necrobia ruficollis*—Latreille's savior" (Cap 1854).

Inscription honoring "Latreille's savior" on the base of Latreille's monument. From Cap (1854).


LATREILLES TOMB.
in the Cemetery of Père la Chaise

Latreille's tomb in the cemetery of Pere la Chaise, Paris. From Jardine (1837).

10

ADDING PAGES

> An imperfect method of description has hitherto greatly impeded the progress of zoological science. Travellers, and especially several of the Linnaean school, have sanctioned this method, because it is easy and expeditious. Limiting themselves to present, in a specific phrase, more or less short, certain characters, omitting a notice of those which, according to this method, were useless for the distinction of the new species from those already known, they thereby obtained only relative descriptions, scarcely sufficient for the wants of Science at the period of their discovery; and which became useless in proportion as new objects required new terms of comparison.
>
> —Report to Academy of Sciences, 1806, in George Ord,
> *A Memoir of Charles Alexander Lesueur*

THE PASSAGE QUOTED above was a rather high-minded conclusion; even its authors, including Cuvier, never upheld it in their own work. In practice, a relative method of description was invoked regardless of one's philosophy; at a given time, certain characters sufficed for separating a species from its relatives. Later, these could be insufficient when other species came to light. It is just not possible, nor was it ever done with copepods, to include every conceivable morphological character in a species description. Happily, detailed descriptions are now increasingly insisted upon.

The period 1600–1800 saw much accomplished in science, and much that can be forgotten. There was more than sheer magnitude; there were perceptions, perspectives, concepts, scope, and detail. Perhaps the last men to grasp it "all" were Humboldt and Cuvier; even Linnaeus, who could recite the entire living world, was at heart and home a botanist. In the last decades of the 1700s, we began to see "entomologists," starting with Fabricius and leading to Latreille; soon there were "carcinologists" breaking away, men like Bosc, Leach, and Risso. And not many decades after that came the first "copepodologists." This progression was never absolute; for nearly a century, friction and inertia mixed taxonomic groups, and interests varied, but the primary focus was clearly, and not surprisingly, toward more specific studies.

* * *

Previous chapters have attempted to indicate the taxonomic fate of each published copepod species since the numbers were manageable and such demonstration is instructive of the process as well as history. But beyond this point in history, species proliferate to such an extent that it is not practical to trace each one to its modern nomenclature. This is not a systematic review; the reader will of necessity have to consult the appropriate monographs or reassessments, or initiate an independent taxonomic study.

The first decade of the nineteenth century saw considerable progress in the classification of crustaceans in general, but there was not very much research on copepods in particular. The New World was not quite ready for it, and the Old World was distracted by wars and revolutions. A good point at which to start the century would be with the summary of crustacean, and copepod, natural history published by Bosc (1802) and with Bosc's exceptionally rich life.

Louis Augustin Guillaume Bosc d'Antic

29 January 1759–10 July 1828

Although Louis Augustin Guillaume Bosc was not an especially important investigator of copepods, he has earned an entry here because his "Natural History of Crustacea" (1802) was the first French book dealing exclusively with this subject. Bosc is better remembered for his astonishing contributions in agriculture and botany, but his wide-ranging applied and academic biological interests touched many fields (Cap 1854).

Bosc's father, Paul Bosc d'Antic (1726–1784), was himself well known in contemporary naturalists' circles and open to all cultural and scientific disciplines (Leroy 1970). He was a native of Tarn, in southern France, and a descendant of Protestants who had been ruined in the Wars of Religion in the late sixteenth century. Although Paul Bosc began medical studies at Montpellier, he was obliged to obtain his degree in Holland because of the family's Protestant beliefs. He is usually remembered as a chemist in the glass industry, in which he had worked with Réaumur. Steadily increasing his reputation, in 1776 he became physician to King Louis XV, an appointment he held into the next reign, until his death (Cuvier 1828).

Louis Bosc was born in Paris. In his youth, he also used the family name d'Antic but prudently dropped this during and after the Revolution. He was early destined for a military career. A maternal uncle and grandfather were generals of artillery. His mother died when he was two years old, and the stepmother was of storybook mold, being interested solely in her own children. Young Bosc was left to roam fields and woods, to which his inner nature responded generously. His boyhood pastime involved collecting insects, minerals, and plants, which did not go unnoticed but was nonetheless discouraged as activity with little tangible reward.

At the age of ten, with a family view toward military arts, Bosc was sent to school in Dijon to study mathematics; his curriculum included botany, to which he eagerly gravitated. Bosc was early exposed to and embraced the Linnaean system. He seemed not to be comfortable with the Latin of Cicero, but the Latin of Linnaeus inspired him. Graduating with honors in

(left) *Louis Bosc (1759–1828). Courtesy of the National Library of Medicine; signature courtesy of the Smithsonian Institution.*

(right) *Louis Bosc (1759–1828). From Perroud (1914).*

1778, he returned to Paris and denounced a military career. Instead, he joined the civil service, obtaining an administrative position in the postal service. Bosc rose quickly in the bureaucracy, while spending his free time reading natural history and becoming personally and idealistically involved with the most perilous of politics (Cuvier 1828, Cap 1854).

Bosc began a lifelong association with the Jardin du Roi, where he began teaching botany under the guidance of the famed Antoine Laurent de Jussieu. In his class of 1780 was Jeanne Manon Roland (1754–1793), newly married to Jean Marie Roland (1734–1793), a Deputy Minister and one of the principals of the French Revolution. The ominous dates of death of the two Rolands, with whom Bosc became friends, will be explained shortly.

Bosc found himself equally enthusiastic in two circles: one comprised the naturalists, with whom he founded the Linnean Society of Paris in 1790 (Rey 1882). In this circle were Buffon and others of his father's acquaintance. Here he met the visiting J. C. Fabricius, a new, intimate, and inspiring friend, and Bosc began serious studies on insects (Cap 1854, Zimsen 1964). Agassiz (1848) and Hagen (1862) listed many Bosc publications pertaining to this subject.

La Perouse visited Buffon in May 1785 to ask his help in recruiting a botanist for the projected voyage around the world. Buffon recommended Bosc. Madame Roland thought that Bosc should not go, so he delayed his response. This delay, probably connected to Bosc's growing notoriety in politics, closed the door; by the time Bosc declined, the choice had already fallen to La Martinière (d'Hondt 1990).

Some of these naturalists, Fabricius included, crossed with Bosc to the other circle, that of politics. Bosc was active in the so-called Jacobin Clubs, to which he had been brought by the Rolands in 1790. By the following year, Bosc became the General Secretary of the Jacobins, an important and all-too-visible position in what by then was a national political party, spearheading the Revolution. He was also a regular attendee at the famous exchanges hosted by Madame Roland, involving many of the greatest philosophers of Europe. Madame Roland was highly regarded for her charm, wit, intellect, and beauty. She was one of the world's first emancipated women and drew admirers by the score. Bosc, being of like spirit, was smitten and became her confidant, protector, and memorializer. Madame Roland and her husband had mortal enemies, and all who associated with them eventually risked violent death (Rey 1882).

Roland became Minister of Interior in 1792; there is no doubt that he allowed to happen—or perhaps planned—a number of atrocities in those frightening days, although in the end he tried to save the king's life. A government reorganization made Bosc the Postmaster General in May 1792. However, Roland and the rest of the Girondin faction fell in May 1793, with the rise of his erstwhile friend Robespierre. Roland went into hiding aided by Bosc (Rey 1882).

Bosc was then very much under the gaze of the politicians with their guillotine. He was betrayed by a naturalist associate and arrested at home (d'Hondt 1990). Taken to his office, Bosc was shown "proof" that he had openly abused his position with regard to secrecy of letters. Bosc was able to show that the ruling Convention itself had given him those powers. Since his department personnel were not as agitated about this matter as were the agents of doom, Bosc was able to resume his duties without dishonor. Nevertheless, a few months later, in September 1793, Bosc was dismissed from his post; being connected with a fallen minister, he was an outlaw without prospects (Cuvier 1828, Cap 1854, Rey 1882).

Madame Roland, unsuspecting or not quick enough, was also arrested in May 1793. Bosc visited her in prison. As a close family friend, Bosc was asked to be the guardian of Roland's daughter Eudora (1781–1858); he also managed to secure and save Madame Roland's famous memoirs (Rey 1882).

Not waiting for more trouble, Bosc timely fled to a friend's secluded cottage and hunting lodge at the ancient priory of Sainte Radegonde in the forest of Montmorency, where Roland himself had recently taken refuge.[1] Bosc and some close friends, similarly outlawed, spent nearly a year in this relative sanctuary, dressed as peasants so as not to arouse suspicions among curious neighbors and the village inquisitor. At one time, agents of The Terror set fire to a small granary where Bosc had hidden; if found, he would certainly have been killed. Bosc and his fellow fugitives subsisted on wild roots, berries, and the eggs of a single chicken. Bosc told of watching in horror as a hawk nearly carried away this valuable support, and only through Bosc's sudden efforts was the chicken reclaimed (Rey 1882).

On a clandestine visit to Paris, Bosc heard of Madame Roland's execution and of her deathless last words: "Oh Liberty, what crimes are committed in thy

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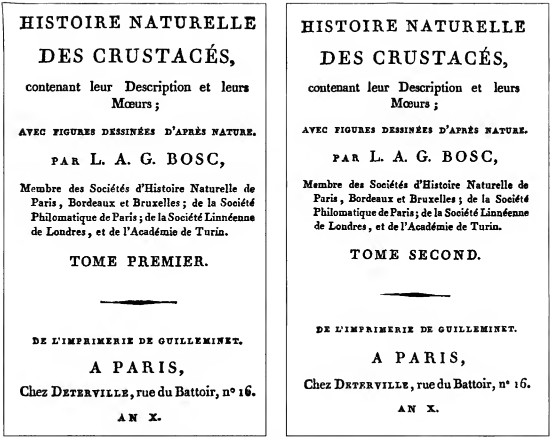
[1] Rey (1882) reproduced an attractive painting of the priory.



HISTOIRE NATURELLE
DES CRUSTACÉS,
contenant leur Description et leurs
Mœurs ;
AVEC FIGURES DESSINÉES D'APRÈS NATURE.
PAR L. A. G. BOSC,
Membre des Sociétés d'Histoire Naturelle de
Paris, Bordeaux et Bruxelles ; de la Société
Philomatique de Paris ; de la Société Linnéenne
de Londres, et de l'Académie de Turin.
TOME PREMIER.

DE L'IMPRIMERIE DE GUILLEMINET.
A PARIS,
Chez DETERVILLE, rue du Battoir, n° 16.
AN X.

HISTOIRE NATURELLE
DES CRUSTACÉS,
contenant leur Description et leurs
Mœurs ;
AVEC FIGURES DESSINÉES D'APRÈS NATURE.
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de Londres, et de l'Académie de Turin.
TOME SECOND.

DE L'IMPRIMERIE DE GUILLEMINET.
A PARIS,
Chez DETERVILLE, rue du Battoir, n° 16.
AN X.

Title pages of Bosc's Histoire Naturelle des Crustacés *(1802).*

name!" The bitter news came, too, of Roland's suicide the day following his wife's death, made doubly bitter with the knowledge that Roland had used a sword-cane that Bosc had given him (d'Hondt 1990).

On 9 Thermidor (27 July 1794), when Robespierre himself was overthrown and passed through the guillotine, the survivors of The Terror were able to come out of hiding. A few remaining friends were restored to authority, and Bosc was offered his old position as Chief of Post. Not wanting to continue an association with some of those who caused his dismissal, he declined. He also said at the time that a career with natural history would be ten times more rewarding (Perroud 1914). Bosc's political strength returned with the installation of The Directory (1795–1799) and the subsequent rise of Napoleon, but he never again desired a seat in the shadow of power.

Bosc became the legal guardian for Eudora Roland in December 1794. The following year, they visited friends and toured the places of recent refuge. Bosc was then thirty-six years old; Eudora, a child of glorified triumphs and severe trials, was mature beyond her fourteen years. Both had been working to publish Madame Roland's memoirs, which they did that year to popular acclaim; twelve thousand copies were sold within six months. Emotionally as well as physically close, Bosc and Mlle Roland became engaged to be married (Perroud 1914).

Bosc the naturalist had already been contemplating a voyage to America. Friends had arranged for him to be a consul representing France in the new United States. Other "friends" were criticizing Bosc, believing that he was taking advantage of his ward and seeking her inheritance. Eudora's wealth was negligible. Bosc, however, was open in weighing with Eudora the advantages and disadvantages of their union, including the age difference (Rey 1882). An amazing number of letters between principals remained to illuminate this personally critical period. Eudora was convinced by others that she should wait. Both Bosc and she became disillusioned, and Eudora broke the engagement in April 1796 (Perroud 1914).

Bosc believed that the age difference was the primary drawback to his marriage plans. There is no doubt that these plans were thwarted by those Bosc believed were friends. However, a modern viewpoint, perhaps then unspoken, is that Bosc, extremely attached and with the strongest reasons to Eudora's mother, saw in the daughter a last desperate way of avoiding a total loss.

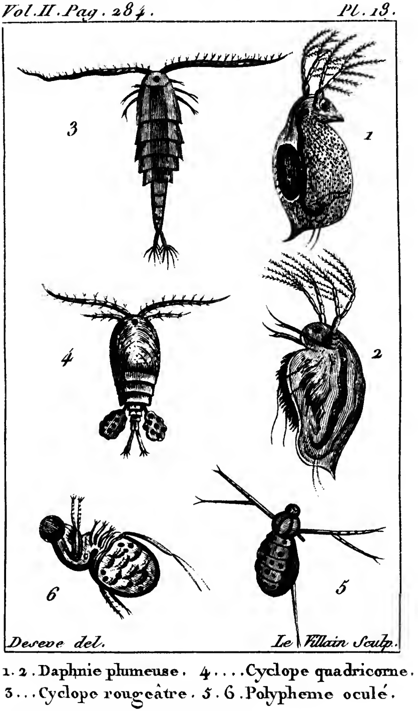
Bosc had hoped to take his bride to America, to "be free of the social prejudices of old Europe." Eudora wished to remain his friend; it was clear there was no longer any passion in her feelings. Bosc, on the other hand, was heartbroken and felt that the best way to proceed with his life was

> to seek distractions in the wilds of America. I am not so attached now to France; my friends are all dead or removed from me by the Revolution.... None of the advantages I had hoped from the Revolution have come about—the corruption and the most vile intrigues as under the old regime have appeared everywhere.... Remember me always with some affection. I carry to the other hemisphere the pleasantness of still having a friend in this one. (Bosc to an ally in Geneva, June 1796, qtd. in Perroud 1914)

Bosc had not yet received the consulship. Since he was still occupying his old government position in name if not in fact, he needed permission to leave the country. On 19 June 1796, The Directory delivered a passport to "Citizen Bosc, naturalist, Administrator-General of the Post, to go to North America, to conduct research on natural history, agriculture, commerce, and the arts" (Perroud 1914).

On 8 July 1796, Bosc left Paris for Bordeaux, going by foot to save the money he would need for the ocean passage. Bosc kept a journal of the natural history along the eleven-day route. One month later, he boarded an American ship, rather than a French ship, because of the open war. This was prudent, for shortly after departure, an English frigate overtook them, but let them proceed. Bosc arrived in Charleston, South Carolina, on 14 October 1796 (Perroud 1914). Bosc did not completely put Eudora behind him with the American voyage. His disappointment was not helped by Eudora's marriage, at fifteen, to the twenty-year-old son of the publisher of her mother's memoirs. However, in later years Bosc and Eudora reconciled and remained close friends (Perroud 1914).

One reason Bosc had gone to America, and to Charleston, was to see his friend, the renown botanist André Michaux (1746–1802); this most praiseworthy man will cross our path again in the story of Lesueur


Vol.II.Pag. 284.
Pl. 19.
3
1
4
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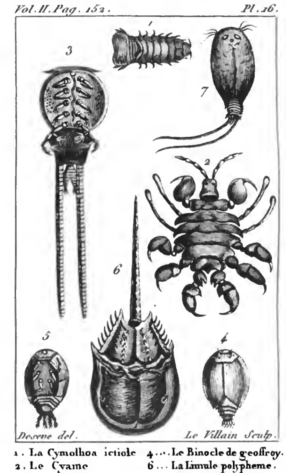
5
Desève del.
Le Villain Sculp.
1. 2. Daphnie plumeuse. 4....Cyclope quadricorne.
3...Cyclope rougeâtre. 5. 6. Polypheme oculé.

Cyclops rubens *(Fig. 3) and* C. quadricornis *(Fig. 4).*
From Bosc (1802).

(Leroy 1957). Unfortunately, Michaux had already returned to France, but Bosc had unrestrained use of Michaux's house and botanical garden on the outskirts of town. Bosc immediately began long, area-wide natural history surveys: "I live as an ancient patriarch, in a cart which serves as a house night and day" (Perroud 1914). Bosc found his long-lost youthful solace in the unspoiled American wilderness, as far west as the Tennessee border. He collected enormous numbers of new seeds, reptiles, amphibians, fish, birds, mammals, mollusks, worms, zoophytes, and insects, which he sent to his naturalist friends, including Latreille, Fabricius, and the herpetologist Bernard Germain Etienne de Laville, Comte de Lacépède (1756–1825). Even without publishing most of these records, Bosc played an extremely important role in early American natural history. The French biological literature of this period is strewn with references to Citizen Bosc, his collections, drawings, and descriptions (Harper 1940).



1. La Cymolhoa ictiole
2. Le Cyame du Cétacés.
3. Callige court.
4. ... Le Binocle de geoffroy.
6. ... La Limule polypheme.
7. ... L'Apus prolongé.

Caligus curtus *(Fig. 3). From Bosc (1802).*

In July 1797, Bosc received the long-awaited appointment as vice-consul at Wilmington, North Carolina. He was named consul in New York in June 1798 but probably never went there. Although both positions gave Bosc a salary, neither was ratified by President John Adams because of tense Franco-American relations. France had not recognized some U.S. delegates, and a reciprocal denial seemed appropriate. Indeed, the two countries nearly came to war at this time, based on the sensitive ambivalence of the United States between the warring France and England. Bosc, now an agent of France, felt obliged to leave America, sailing from Charleston toward the end of July 1798 on a ship bound for Spain.

Arriving at Corunna in September 1798, Bosc characteristically walked to France, publishing the resulting natural history review of northwest Spain in 1800. He had noticed the strong relations between geology and vegetation, and later, perhaps for the first time, pointed out the competition between different cultivated species. Bosc crossed into France, stayed with various friends, obtained a horse in Bordeaux, and was back in Paris by the last day of November 1798. In April 1799, Bosc married his cousin, Suzanne Bosc (Perroud 1914).

From this time, Bosc dedicated essentially all of his efforts to natural history and agriculture. For a decade, his publications had found a consistent outlet in the "less combustible elements" of the Société Philomatique (Cuvier 1828). Bosc moved to fill a scientific void in France by the publication, in 1801 and 1802, of comprehensive works on the "Natural History of Shelled Molluscs" (five volumes), the "Natural History of Worms" (three volumes), and the "Natural History of Crustaceans" (two volumes) (Agassiz 1848).

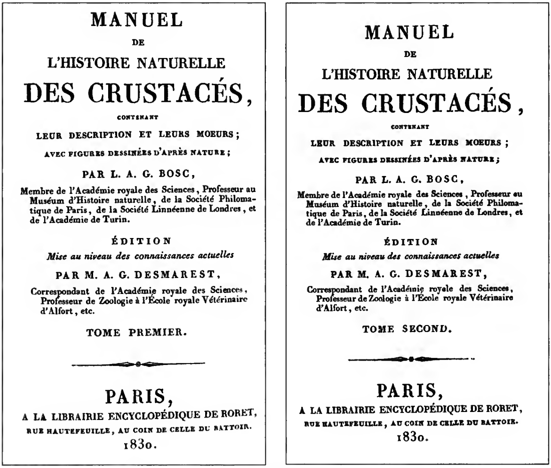
Bosc's *Histoire Naturelle des Crustacés* was published in 1802, the Tenth Year ("An X") of the Republic. Bosc reviewed crustacean classification, described Fabricius's methods of mouth and mouthpart characteristics, and described crustaceans within a variant of Lamarck's 1801 system. He acknowledged that Lamarck was the first to hold crustaceans distinct from the insects, but Bosc, following Cuvier, thought that this distinction might be premature. Therefore, the whole work was encompassed under the "Insectes." The classification was inconsistent; in one place, Bosc indicated the two orders of interest, Crustacés and Entomostracés. In the table of classification, he included all crustaceans under the two Lamarckian sections Pedioclés and Sessilioclés. The latter, with one group having the body covered with many crustaceous pieces, included *Cyclops* as well as the Bosc genus *Zoea,* now known to be a larval decapod. A second sessile-eyed group, having the body covered by one or two pieces, included *Caligus* and *Binoculus.*

Bosc's intention was to describe all of the species that might be found in the waters of coastal or inland France. Of *Cyclops,* he said that some are found in stagnant water, corrupted with vegetation, and others are found in the sea:

> One sees them everywhere, at least in the Paris area, all year around, but especially in the springtime. They serve, as do other members of the class Entomostraca, as food for all aquatic insects, for all the worms living with them, and especially for aquatic birds. The same causes of destruction affect them all. (Bosc 1802)

However, the only *Cyclops* species listed were those of Müller (1785), and of Müller's thirteen species, only *C. curticornis* (an unidentifiable copepod) was missing. Only two were illustrated and those not well: *C. rubens* and *C. quadricornis.* Müller's *Caligus* species, *C. curtus* and *C. productus,* were also included, with an illustration of the former.

Bosc was aware of De Geer's work, and of a recently published paper of Jurine, citizen of Geneva, on the development of entomostracans. Bosc added some new notions, however, particularly that the male reproductive process somehow involved the first antennae. More important, Bosc pointed out that the genera *Amymone* and *Nauplius* of Müller



MANUEL
DE
L'HISTOIRE NATURELLE
DES CRUSTACÉS,
CONTENANT
LEUR DESCRIPTION ET LEURS MOEURS;
AVEC FIGURES DESSINÉES D'APRÈS NATURE;
PAR L. A. G. BOSC,
Membre de l'Académie royale des Sciences, Professeur au Muséum d'Histoire naturelle, de la Société Philomatique de Paris, de la Société Linnéenne de Londres, et de l'Académie de Turin.
ÉDITION
Mise au niveau des connaissances actuelles
PAR M. A. G. DESMAREST,
Correspondant de l'Académie royale des Sciences, Professeur de Zoologie à l'École royale Vétérinaire d'Alfort, etc.
TOME PREMIER.

PARIS,
A LA LIBRAIRIE ENCYCLOPÉDIQUE DE RORET,
RUE HAUTEFEUILLE, AU COIN DE CELLE DU BATTOIR.
1830.

MANUEL
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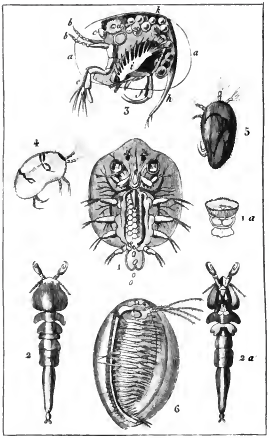
TOME SECOND.

PARIS,
A LA LIBRAIRIE ENCYCLOPÉDIQUE DE RORET,
RUE HAUTEFEUILLE, AU COIN DE CELLE DU BATTOIR.
1830.

Title pages of Bosc's Manuel de l'Histoire Naturelle des Crustacés, *as revised by Desmarest (Bosc and Desmarest 1830).*

Dichelesthium sturionus *(Figs. 2–2a). From Bosc and Desmarest (1830).*



1. Argule foliacé fem. en dessous 1 *a*. l'une de ses ventouses.
2. et 2 *a*. Dichelestion de l'Esturgeon en dessus et en dessous.
3 Anatomie de la Cypris brune d'après M. Straus.
4. Cypris veuve. 5. Cypris à une bande.
6. Limnadie d'hermann.

were merely larval stages of *Cyclops.* In regard to the small crustaceans, Bosc stated that "there is no way to preserve them other than in spirits of wine [i.e., alcohol]. The softness of their bodies or the flexibility of their test is such, that one cannot retain much after they are dried" (Bosc 1802).

It seemed not to have occurred to him that his new genus and species *Zoea pelagica,* discovered in the ocean during his trip to America, was the larval stage of a decapod. Like "nauplius," the word "zoea" was later adopted as the general term for that larval stage.

There was one last gasp of medieval mythology in Bosc's natural history: "The crabs . . . in warm countries can reach such a great size that they can attack men, and have eaten many, among others, the famous navigator François Drack, who, although armed, was unable to avoid this fate" (Bosc 1802).

In the new edition of the "Natural History of Crustaceans" (Bosc and Desmarest 1830), there was some updating in the introductory material. Latreille, Cuvier, Leach, Risso, and Jurine were added to the roll of workers, and many new genera were listed—including *Anthosoma, Cecrops, Dichelesthium* (illustrated), *Nogaus, Pandarus,* and *Risculus.* There was a better discussion of crustaceans as they are related to the other invertebrates, and comparative anatomy was included. Crustaceans were a distinct Lamarckian class, between the mollusks and arachnids, and somewhat close to insects. Barnacles still held in mollusks were thought to be a transition group between mollusks and crustaceans. Nevertheless, the main text is unchanged, having all crustaceans within insects. But the point was well made that Crustacea now represented a science in themselves. Bosc's new edition was in the publisher's catalog as late as 1870, available with colored plates (for 8 francs) and without (for 4 francs 75 centimes).

Bosc did not include the zoophyte copepods (the lernaeids) in his natural history of crustaceans, since to him they were not crustaceans. He mentioned eighteen species of *Lernaea* (broad sense, including the Linnaean copepods under *Pennatula*) in his 1802 natural history of worms, saying that they were mollusks closely related to the intestinal worms (Wilson 1917a). In spite of the advances of the previous decade, Bosc's second edition of "Natural History of Worms," in 1830, added no new species and no reorganization for the copepod forms.

Soon after 1800, Bosc undertook a government scientific excursion through Italy and Switzerland, returning with a large collection of fishes to enrich the museum (Cap 1854). After the publication of his three natural histories, Bosc turned more toward applied biology and to agriculture. He had already begun to contribute to an agricultural encyclopedia and a dictionary, and this was continued into the 1820s. He was a collaborator on a large agricultural book and was a leading editor of the *Annales de l'Agriculture Française* (1811–1828), in which he published about sixty articles (Cuvier 1828). Bosc was named Inspector of Gardens and Nurseries in 1803, and he became a member of the Academy of Sciences in 1806. Bosc replaced Thouin as Professor of Horticulture at the museum in 1825 (Leroy 1970).

While traveling in southeast France in 1824, Bosc was surprised by a violent storm. He contracted a fever, leading to a chronic infection that impaired him during his last years. He died in 1828, highly respected by his contemporaries for his dedication to his friends and to science (Cuvier 1828). At his funeral, four eulogies were given: by Duméril for the Academy of Sciences, by Virey for the Academy of Medicine, by Cuvier for the Museum of Natural History, and by Baron Silvestre for the Royal Society of Agriculture. Bosc was buried in the cemetery at Sainte Radegonde, alongside an infant daughter who died in 1801. The old priory was thus a Bosc sanctuary for a second, and final, time. He left numerous books, specimens, and manuscripts to the National Museum of Natural History. Among the latter was the "Spiders of the Forest of Montmorency—1793"; even while running for his life, Bosc took time to record eighty-nine species (Leroy 1970). Bosc's library was sold at auction in January 1829, with a printed catalog of sixty-nine pages.[2]

Jean Frédéric Hermann

? 1768–19 January 1794

Jean (or Johann) Frédéric Hermann was introduced under his father's publication from 1783. The junior Hermann's lasting impact came with a posthumous paper published in Strasbourg in 1804, within a larger study on apterous insects (Kabata 1979, Vervoort 1986b). The older paper is mentioned by Agassiz under J. Hermann. The apterous insect paper of 1804 is listed under J. Fr. Hermann, who Swainson (1834) said was the son of the former. The ranges of dates of all publications under both names are virtually identical. The 1804 paper made more distinctive copepod history by describing *Dichelesthium,* one of the oldest copepod genera. In spite of its venerable age, *Dichelesthium* has not been mired in the confusion that typically accompanied the early genera (Kabata 1979). J. F. Hermann found this copepod as a parasite on sturgeon and named it *D. sturionus.* Unfortunately, Abildgaard, in the year of Hermann's death, had described the species as *Caligus oblongus*; therefore, this copepod remains as *Dichelesthium oblongum* (Abildgaard, 1794), a congenial combination of Hermann's genus and Abildgaard's species. In his work, Hermann also included *Argulus foliaceous* of Linnaeus (see Wilson 1902). A measure of the rarity of Hermann's 1804 Strasbourg publication is suggested by Rathke's (1839) inability long ago to consult it, as well as my inability now.

J. F. Hermann is remembered for a 1788 work on corals, also published in Strasbourg. Agassiz (1853) also listed a significant publication on comparative osteology from 1792.

The date of the young Hermann's death suggested to me that he may have run afoul of some Revolutionary zealots. However, Lauterborn (1903) reported that he died of typhus, leaving a grief-stricken father who had the highest hopes for his son to succeed him. Apparently my fears were close to the truth, for young Hermann's brilliant promise was cut short when he was conscripted as a physician to a military hospital where he died of a "contagion" (Cuvier 1817b, de Morembert 1989). (His father's reaction was described in Chapter 8.)

Data from the American Museum of Natural History Library on J. F. Hermann's 1804 publication indicated that he had been a Doctor of Medicine and a member of the Natural History Society of Paris. Cuvier (1817b) recorded Hermann's death as 1793, rather than 1794; the confusion may be due to conversion from the Revolutionary calendar.

Karl August Ramdohr

?–?

At this point, Karl August Ramdohr remains a man of mystery. He seemed to be obscure even in his own time, since his works were not widely reported. I cannot even determine the dates of his birth and death. Ramdohr deserves much better than this, for his work was beyond that of most of his contemporaries.

In an 1805 "Report on the Natural History of Some German *Monoculus* Species," part of a larger work on helminths and insects published in Halle (Vervoort 1986b), Ramdohr described the reproduction and development of *Cyclops* species (Giesbrecht 1892). According to Baird (1850), this was "a very correct account of the anatomy, &c. of three species found in fresh water, accompanied with plates, which possess very considerable accuracy, and traces their whole transformation from the egg to the perfect animal." This was new and solid information, but, as with so many other publications from this period, Ramdohr's monograph was not widely distributed, and these good observations had to be remade by others more than a decade later. We will not see anything comparable to this until Jurine (1820), who seemed to be unaware of Ramdohr's discoveries.

Baird (1850) reported that Ramdohr had the old and ill-defined *Cyclops quadricornis* and some variet-

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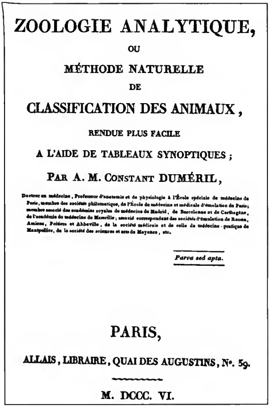
[2] Listed in the Harvard University Library catalog.



ZOOLOGIE ANALYTIQUE,

OU

MÉTHODE NATURELLE

DE

CLASSIFICATION DES ANIMAUX,

RENDUE PLUS FACILE

A L'AIDE DE TABLEAUX SYNOPTIQUES;

PAR A. M. CONSTANT DUMÉRIL,

Docteur en médecine, Professeur d'anatomie et de physiologie à l'École spéciale de médecine de Paris, membre des sociétés philomatique, de l'École de médecine et médicale d'émulation de Paris; membre associé des académies royales de médecine de Madrid, de Barcelonne et de Carthagène, de l'académie de médecine de Marseille; associé correspondant des sociétés d'émulation de Rouen, Amiens, Poitiers et Abbeville, de la société médicale et de celle de médecine-pratique de Montpellier, de la société des sciences et arts de Mayence, etc.

Parva sed apta.

PARIS,

ALLAIS, LIBRAIRE, QUAI DES AUGUSTINS, N°. 59.

M. DCCC. VI.

Title page of Duméril's Zoologie Analytique *(1806).*

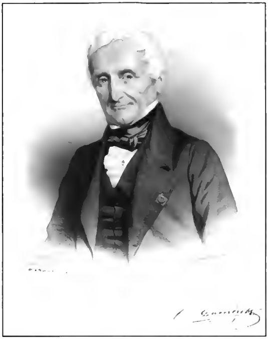
ies, as well as *Cyclops lacinulatus,* which Baird thought might be *Diaptomus castor* (Jurine, 1820). Ramdohr also included a second Müller copepod, *C. minutus.* Two of Ramdohr's other *Monoculus* species were cladocerans, and a third was an ostracod.

Agassiz (1854) listed ten Ramdohr papers (1805–1819), mostly about helminths and insects (especially honeybees). One report is of an ostracod. From the publications, Ramdohr seems to have been affiliated with Halle, Germany, perhaps with the university.

André Marie Constant Duméril

1 January 1774–14 August 1860

André Marie Constant Duméril, friend and collaborator of Cuvier, began his long and fruitful life in Amiens, France. After some medical studies, he was placed at nineteen years of age as a demonstrator at the School of Anatomy in Rouen. The following year, 1794, he assumed the same duties at the Faculty of Medicine in Paris. He became a member of the Société Philomatique in 1796, one, two, and three years, respectively, after Cuvier, Bosc, and Lamarck. By 1801, Duméril was Professor of Anatomy in the distinguished Paris school (Pizzetta 1891). Napoleon's wars placed Duméril as a physician confronting cruel epidemics in the middle of Spain in 1805 (Milne Edwards 1860).



Constant Duméril (1774–1860). Courtesy of the Wellcome Institute Library, London.

Duméril became a member of the Academy of Sciences in 1816. Through his relationship with Cuvier, he obtained the Chair of Herpetology and Ichthyology at the Museum of Natural History in 1825, following the death of Lacépède.

Of interest to us is Duméril's (1806) small but suitable *Zoologie analytique,* with a "natural method for the classification of animals." He did not at all attempt to place the lernaeids. Duméril's classification of crustaceans was a modification and renaming of Latreille's system from 1802–1805, with no real gain in precision (see also Desmarest 1825):

Class Crustaces
  Order I. Entomostraces
    Family 1. Aspidiotes or Clypeaces, including *Caligus, Binoculus, Ozolus*
    Family 2. Ostracins or Bitestaces [including ostracods and cladocerans]
    Family 3. Gymnonectes or Denudes, including *Argulus, Cyclops, Zoea*
  Order II. Astacoides
    Family 4. Carcinoides or Canceriformes

        Family 5. Oxyrhinques or Mucrones
        Family 6. Macroures or Longicaudes
        Family 7. Arthrocephales or Capites
        [including stomatopods, mysids, amphipods]
  Class Insectes
    Order VIII. Apteres
      Family 60. Polygnathes or Quadricornes
      [including isopods]

Duméril repeated Jurine's earlier assertion that Müller's nauplii and amymones were juvenile *Cyclops.*

In 1802, Duméril wrote the two-volume "Elements of Natural History," which remained popular for a generation; a fourth edition appeared in 1825. Agassiz (1850) listed sixty Duméril publications, some coauthored with Latreille (insects) and de Blainville (mollusks). In 1823, Duméril published his *Considérations générales sur la Classe des Insectes,* the model for Desmarest's (1825) classic work on crustaceans; we will review this work in Chapter 12.

Duméril was considered the last of the line of naturalists formed in the eighteenth century who built a strong base for zoology in the nineteenth century. The vice president of the Academy of Sciences, one of six speakers at Duméril's impressive funeral, said that

> it will not only be as a scholar that M. Duméril will be missed by the Academy. It will also be for his loyal and firm character, his unaffected sincerity, his impartiality, the calmness of his interactions, and the strength of his friendships; these have gained the respect and affection of all of his colleagues, and these sentiments inspire all of us who knew him. (Milne Edwards 1860)

In 1818, Lesueur described a new species of angel shark, *Squatina dumeril*: "I have dedicated this fine species to M. Duméril, in testimony of my remembrance and esteem." Duméril was named Honorary President of the Entomological Society of France in 1832.

James Sowerby

21 March 1757–25 October 1822

The Sowerby family comprised a number of gifted naturalists that especially influenced the development of botanical and conchological illustration and description in nineteenth-century Great Britain. The principals wrote or illustrated several hundred works on botany, mineralogy, paleontology, and zoology during more than 150 years (Cleevely 1974, Macdonald 1974).

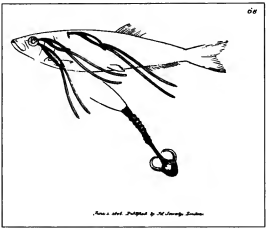
Drawn by T Heaphy May 1816
Engraved by J.C.Edwards
JAMES SOWERBY, F. L. S: G. S. &c.
Nat: March 21, 1757. _Ob: October 25, 1822.

James Sowerby (1757–1822). From Journal of the Society for the Bibliography of Natural History *6(6) (1974): frontispiece.*

James Sowerby was the first member of the family to publish on natural history. He was born on Fleet Street in London. His father, John Sowerby, was a hereditary guild member and lapidary, a worker of precious stones for jewelry, and thus had mechanical and artistic talents. Such talents, particularly drafting, were revealed early and even startlingly in James's life.

James's father died in 1766, leaving a large family with the eldest son, named John after his father, not yet able to take over the family craft, which was in any case declining because of a decrease in the fashionable use of colored stones. James had already learned the value of and demand for his sketches and portraits among his acquaintances, and with a broadening of the sales base he was able to support his mother, two brothers, and sister.

At the age of fourteen, James was apprenticed to a celebrated painter of seascapes and spent a year, before this artist died, improving his already impressive skills. By 1776, James had enrolled as a



Lernaea sprattae. *From Sowerby (1806).*

student in the Royal Academy. His own interests had turned toward natural scenes, and he began spending time afield with special regard to trees and smaller plants. (Sowerby later exhibited many of his paintings at the Academy through 1790.) His creations were noticed by connoisseurs, and particularly by William Curtis (1746–1799), botanist and publisher of the *Botanical Magazine,* whom Sowerby had sought out through his similar interests. Curtis hired him to prepare colored plates for the magazine and other publications. Sowerby then learned engraving and applied some new techniques to botanical illustration. His principal income, however, was still portrait painting.

A fellow student at the academy had described his youngest sister to Sowerby in such detail that Sowerby prepared her portrait. A subsequent visit with the family, in Norwich, to compare the image with reality, resulted in Sowerby's eventual marriage in 1786 to the subject, Anne de Carle (1764–1815). They had nine children, the beginning of five generations of naturalists (Macdonald 1974, Simpkins 1974).

An increased need for money led Sowerby to paint exotic plants for wealthy collectors, including Joseph Banks. He soon made the acquaintance of Sir James Edward Smith, already mentioned in connection with the purchase of Linnaeus's collections. Sowerby and Smith became lifelong friends. Sowerby illustrated some works for Smith, and Smith prepared the text for their joint illustrated work, the grand *English Botany* (published from 1790 to 1814).

Sowerby became a member of the Linnean Society in 1791, the society's third year, and a Fellow in 1793. His energies were now exclusively toward natural history illustration and collecting, primarily birds, exotic minerals, and shells, both recent and fossil (Simpkins 1974). Sowerby corresponded with virtually every established naturalist in Great Britain, and a large quantity of this correspondence found its way to the British Museum (Macdonald 1974). Sowerby became a founding member of the Geological Society in 1808. Another vital Sowerby offering was the *Mineral Conchology of Great Britain,* consisting of seven volumes published from 1812 to 1846. Sowerby was also a collaborator and friend of Leach, for whom Sowerby prepared fifty-four colored plates for the first seventeen parts of Leach's *Malacostraca Podophthalmata* (1815–1820). Cleevely (1974) listed fifty-four works that Sowerby authored or for which he made significant contributions.

James Sowerby's eldest son, James de Carle Sowerby (1787–1871), followed his father's lead (Cleevely 1974). Although the younger Sowerby did not publish original works on copepods, he illustrated papers and monographs for many naturalists who will be central to our narrative for Victorian England. We will soon encounter William Turton, a representative just prior to this period; the plates for his monograph on British mollusks, from 1831, were done by J. de C. Sowerby. Others whose publications benefited from this Sowerby's illustrations, and who will be mentioned in detail, are Joshua Alder, George J. Allman, William Baird, William B. Carpenter, Charles Darwin, Edward Forbes, Harry D. S. Goodsir, Philip Henry Gosse, Albany Hancock, George Johnston, John Lubbock, Alfred Merle Norman, Robert Templeton, William Thompson, and Wyville Thomson.

Amid this flurry of activity is one copepod with a fine drawing, as would be expected from such a master, by the senior James Sowerby. This is from the second (and last) volume of Sowerby's (1806) *British Miscellany,* a collection of seventy-six plates and descriptive text on a variety of insects and other invertebrates as well as birds and both land and marine mammals. It was produced in twelve installments from December 1804 to August 1806, the last two installments comprising the second volume.

Sowerby's copepod was *Lernaea sprattae,*[3] a common North Atlantic and western Mediterranean parasitic copepod. This species is usually found embedded in the eye of sprat, but it is occasionally found on pilchard and herring, sometimes embedded also in the dorsal part of the body, as shown by Sowerby (Kabata 1979).

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[3] Now *Lernaeenicus sprattae* (Sowerby, 1806).

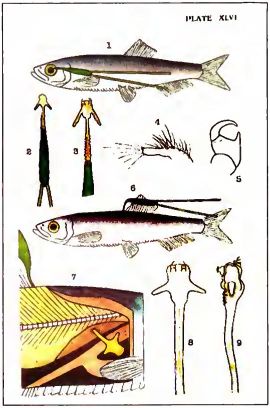
Sowerby (1806), following conventional zoology of the period, placed these animals in the Class Vermes, order Mollusca. He noted for general characters that the body was red, oblong, roundish, and naked, with two or three round tentacles and two green "oviducts." The specific characters included a head with two barbs and a notched neck. Sowerby related that

> in November 1799 and 1804, I observed this strange and curious animal fixed to small Sprats (*Clupea Spratta* of *Linn.*). Its body shaped like an oat, and its two green tails, might create an idea of its being a vegetable, but that the body is red, and has a fleshy aspect; yet the unorganized appearance is very strange, and sufficient to induce any one desirous of information to examine further. If we are careful we may detach it, but not without wounding the subject it preys upon; which if we do, so as to kill it, I venture to pronounce it as more merciful than otherwise. This, which I can but consider as a grievous parasite, like a harpoon inflicts a dreadful wound; but, more fatal than that instrument, not only wounds, but preys upon the innermost part of the wretched victim, probing and feeding very deep into any part it pleases. (Sowerby 1806)

I have a charming and colorful book, the *Popular History of the Aquarium*, by James Sowerby's grandson, George Brettingham Sowerby II (1857), who devotes a short section to "this strange and curious animal":

> When the creature attaches itself to the head, near the eye of the sprat, it buries its head in the substance of the poor fish, from which it cannot be extricated without tearing the neck off, the two side hooks taking so firm a hold in the flesh. In Sowerby's "Miscellany" is a figure of an unfortunate sprat so ornamented, looking as if some submarine bull-fighter had baited him with harpoons and gay streamers. . . .
>
> We have now however dwelt long enough on a class which, however interesting, must not be permitted to encroach upon space which can hardly be spared from the more peculiar objects of Aquarian study. (Sowerby 1857)

Even though it would be difficult to imagine any "more peculiar objects" than these parasitic copepods, the Victorian readership was doubtless anxious to return to its feather-dusters, feather-stars, hermit crabs, and mermaid's gloves—popular organisms in aquariums of the period.



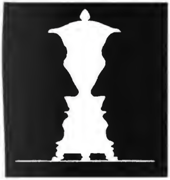
Lernaeenicus sprattae *(Sowerby, 1806) (Figs. 1–5) and* L. encrasicoli *(Turton, 1807) (Figs. 6–9). From Scott and Scott (1913).*

William Turton

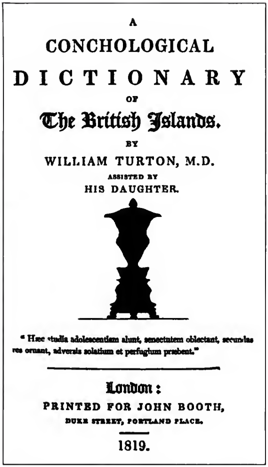
21 May 1762–28 December 1835

William Turton, M.D., an 1809 Fellow of the Linnean Society, included four copepods in the first volume of his *British Fauna.* Turton's (1807) compendium of the zoology of the British Islands was "arranged according to the Linnean system." Turton's text had a delicate evolutionary flavor:

> Orders are divided into Genera or families, ultimately subdivided into species or individuals, with their accidental *varieties.* Local arrangements, systematically exhibited, have ever been considered as highly subservient to a general knowledge of natural history; inasmuch as by the contemplation of a smaller range, the



William Turton (1762–1835), as revealed by a negative enlargement of the decorative urn from the 1819 title page of A Conchological Dictionary.



A
CONCHOLOGICAL
DICTIONARY
OF
The British Islands.
BY
WILLIAM TURTON, M.D.
ASSISTED BY
HIS DAUGHTER.

" Hæc studia adolescentiam alunt, senectutem oblectant, secundas res ornant, adversis solatium et perfugium præbent."

London:
PRINTED FOR JOHN BOOTH,
DUKE STREET, PORTLAND PLACE.
1819.

The decorative urn on the title page of A Conchological Dictionary *concealed double silhouettes of William Turton (1762–1835), who declared that "This study nourished my youth, and amuses me in old age; by following the productions of nature, I am provided with solace and a refuge." Courtesy of the California Academy of Sciences; revelation by Richard N. Kilburn, Natal Museum, South Africa.*

> various objects contained in it may be more accurately examined and described. (Turton 1807)

Under the "Worms, Mollusca," two of the copepods were Linnaeus's *Lernaea cyprinacea* and *L. salmonea.* A third was *L. sprattae* described by Sowerby the previous year, and a fourth was a new species that Turton named *Lernaea encrasicoli,* from herring and sprat in Swansea Bay. The latter two are now valid species in the genus *Lernaeenicus* (see Brian 1906, Wilson 1917a, Kabata 1979).

Turton, who is remembered as a conchologist, was born at Olveston, Gloucestershire, on the eastern side of the mouth of the Severn. His father was a solicitor. Turton graduated from Oxford in 1785 and obtained his medical degree there in 1791. He was a practicing physician but, like so many others in this narrative, devoted his leisure hours to natural history.

Although he was not widely traveled, Turton lived and doctored in several colorful towns: Swansea, on Bristol Channel in southern Wales; Dublin, Ireland; Torquay, Devonshire, on the English Channel; and Bideford, near the Devonshire coast, where he died.

Charles Kingsley (1819–1875), novelist, canon of Westminster, and Professor of History at Cambridge, left us a ten-year-old's fleeting glance at "poor dear old Dr. Turton":

> Five-and-twenty years ago, during an autumn's work of dead-leaf-searching in the Devon woods for poor old Dr. Turton, while he was writing his book on British land-shells [1831], the present writer learnt more of the art of observing than he would have learnt in three years' desultory hunting on his own account. (Kingsley 1856)

In 1797, Turton published a six hundred-page medical glossary. Turton's large collection of shells passed through several hands and is now at the U.S. National Museum (Anon. 1899). *Turtonia,* a bivalve, was named for him by Edward Forbes.

François Etienne Delaroche

9 December 1781–23 December 1813

It was not until the final draft of this volume that I came to know something substantial about François Etienne Delaroche. As with our other colleagues, he is a man of some mystery and much interest. His last name is sometimes spelled "De la Roche." Agassiz (1850) listed three Delaroche papers about fishes, all in Parisian journals. Having also contributed in nonrelated fields, Delaroche has had the distinction of being counted as two individuals (Mac Arthur 1990).

Before probing Delaroche's short and busy life, I must first introduce two other men, neither of whom had direct involvement with copepods. The first is Delaroche's father, Daniel Delaroche (1743–1813), originally from the Republic of Geneva. The senior Delaroche went to Leiden in 1763 and obtained a medical degree, with a botanical thesis, at the University of Leiden in 1766 and later studied at Edinburgh. He returned to Geneva as a practicing physician for ten years, and there his son François was born (Hirsch 1885). In 1782, the family removed to Paris "for political reasons" (Mac Arthur 1990), where Delaroche was appointed physician to the Swiss guards (the only guard units that stood by the king during the Revolution). In 1790–1792, Daniel Delaroche coauthored the surgical volumes for the *Encyclopédie Méthodique.* During the Revolution, in 1792, the Delaroche family was obliged to leave Paris, first for London and then for Lausanne on the north shore of the Lake of Geneva. They remained in Lausanne for several years, returning to Paris by the end of 1798 (Borgeaud 1909). The senior Delaroche retained his early interest in botany, especially its medical applications; Scopoli named a legume *Rochea* after Delaroche. Upon returning to Paris, Delaroche met and aided the young Swiss botanist Augustin Pyramus de Candolle (1778–1841) (Briquet 1940). From 1802, Delaroche was physician in the Maison de Sante, Paris. He was noted there for his closeness to the vaccination movement from the time of its introduction on the continent in 1798 (Mac Arthur 1990).

The other vital person in François Delaroche's story was the Swiss physician/physicist Jean François Berger (1779–1833), a favorite pupil of Louis Jurine, already briefly introduced (see Chapter 12 for an in-depth review of Jurine). Jurine selected Berger as the companion in his younger son Andre's studies. Both Berger and André Jurine qualified in Geneva to practice medicine and then went together to Paris in 1802 to obtain their doctorates. Berger, at least, studied under Daniel Delaroche (Mac Arthur 1990).[4]

François Delaroche's earliest studies were in Paris, then in England and Lausanne where the family marked time during the Revolution. By the time the family returned to Paris, Delaroche's studies were decidedly toward medicine. He, like his father, became friends with de Candolle, and they collaborated in botanical and physics projects. A plant genus, *Franciscaria,* was named for François Delaroche by de Candolle. Delaroche and de Candolle undertook a botanical survey of the Nantes region, and in 1806 Delaroche published a monograph of two plant genera; this was followed by three volumes of text for the artist Pierre Joseph Redouté's (1759–1840) monograph on lilies. Delaroche's introduction to the laboratory at Arcueil (see below) put him in contact with the country's leading scientists, and he received special encouragement from Lamarck, Humboldt, Bosc, and de Jussieu (de Candolle 1862, Briquet 1940). In 1803, François Delaroche, André Jurine, and Berger toured Normandy and Picardy, one of several journeys described by Berger in a travelogue published in 1807. Berger obtained his M.D. in 1805; one of his examiners was Duméril, a brother-in-law of François Delaroche (Crosland 1967).[5] Berger then assisted Delaroche in his doctoral research concerning animal heat. This was finished the following year, and Delaroche was granted an M.D. by the School of Medicine in Paris in 1806. His thesis was published in translation by the Royal Society of London. It was also cited

Alexander von Humboldt (1769–1859), cosmopolitan explorer, scholar, naturalist, and friend to early copepodologists. From Feudel (1971).

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[4] It is not clear whether André Jurine qualified for his doctorate in medicine; to the sorrow of his family and friends, he ended his own life in 1807 in Paris (C. Mac Arthur, pers. comm., December 1997). Berger remained a lifelong friend of Louis Jurine and was present at his deathbed in 1819. Jurine's fabulous natural history cabinet was entrusted to Berger. Berger also assisted in the posthumous publication of Jurine's manuscripts, with a debt of gratitude from copepodologists eternal. Ever a small world—I must also mention that Berger spent three months, in 1806, traveling in Italy with the geologist William Maclure (Mac Arthur 1990). Maclure will be mentioned in Chapter 13.

[5] Delaroche's sister, Alphonsine, had been married to an army officer who was killed at the siege of Acre in 1799. A few years later, she married Duméril (C. Mac Arthur, pers. comm., December 1997).

as significant toward the end of the century by the French physiologist Claude Bernard (1813–1878) (Mac Arthur 1990).

The mention of Arcueil requires a diversion. One of the most prominent scientists of Napoleonic France was the chemist Claude Louis Berthollet (1748–1822). Berthollet, a native of Savoy (now France, but then a part of the Kingdom of Sardinia), having shared dangers of battle with Napoleon became a respected and trusted advisor. He also became rich through his several appointments within the Revolutionary government. Unlike many contemporaries with similar good fortune, Berthollet returned his resources to the service of science. In 1802, he purchased an estate at Arcueil, three miles south of Paris, and there he installed a superb chemical and physical laboratory. Berthollet's laboratory attracted the brightest of established scientists but was also an unexcelled opportunity for several promising young scientists. Berthollet had a wide correspondence with foreign scientists, and his laboratory was a mandatory site to visit (Crosland 1967).

By 1807, Berthollet's close circle became a private society, the Society of Arcueil, with its own published memoirs. The laboratory and the society rose and fell with Napoleon, but while it flourished no place had a greater reputation, nor did any other facility offer so much in the way of encouragement, experience, and advancement. The society had only fifteen full members, but all were notable, and all, at least eventually, were members of the Institute of France. Society members included the mathematician Pierre Simon Laplace (1749–1827), the polymath Alexander von Humboldt (1769–1859), the chemist Joseph Louis Gay-Lussac (1778–1850), and the botanist de Candolle. Because of their prestige and placement, a recommendation from the members had great weight in any subsequent appointments to the institute, an academy, or a government bureau.[6]

One of the bright young men that Berthollet invited to Arcueil was François Delaroche. Arcueil provided a unique workplace and an atmosphere of free discussion among friends. It was science at its very best—during a period in history that held the best and worst in so many spheres, although France was surprisingly liberal with foreign scientists. A Genevan like Delaroche would have appealed especially to Berthollet, hailing from a neighboring region, and of course Geneva was French at that time, and Delaroche's father was well placed. Even though the French were at war with Prussia, we still see men like Schweigger and Otto being educated in Paris during this period. Napoleon always considered Humboldt a Prussian spy but was persuaded not to expel him because of his renown and his value to French science. This rankled Napoleon, and on the several occasions when the two men met, Napoleon made a point of asking Humboldt for his name once again.

Most of François Delaroche's work was carried out at Arcueil. In light of the severely restricted membership, Delaroche has been termed an "associate member" although there was no such category. He attended the meetings of the society and was definitely more than a visitor (Crosland 1967). De Candolle (1862), however, said that Delaroche was "admitted" to membership. Delaroche's studies went primarily to physics in which he established a name for himself, although he made contributions to zoology, medicine, and physiology.

In 1807, Delaroche was elected to the Société Philomatique. He was also a charter member that year of the Society of Amateurs of Physical and Natural Sciences of Paris, a predominately medical and natural history gathering with self-limited membership. The next year this group changed its name to the Society of Physical and Natural Sciences. They published their memoirs only in 1807, and the society soon vanished.

At this point, Delaroche's (1811) copepod contribution enters the story, but not without a bit of background. The metric system, adopted by postrevolutionary France, was supposedly a natural system. The meter was to be one ten-millionth of the earth's quadrant, measured along a meridian (specifically the imaginary line running north-south through Paris). Since the earth was by then known to be a somewhat flattened sphere, and this meridional measurement would therefore differ if it were measured near the poles or near the equator, it was decided to measure it centered on latitude 45° North, necessitating a careful measurement of the extension of an arc already surveyed from Dunkirk to Barcelona. This extended arc would run through Spain and into the Balearic Islands, one of which is Majorca. In 1806, the French government, through its Bureau of Longitude, asked two members of the Society of Arcueil to superintend this work in the field. The society in turn asked Delaroche to be the expedition's naturalist (Crosland 1967). Thus it was that Delaroche found his way to Majorca and into copepod history.

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[6] The closest to a latter-day counterpart may be the Stazione Zoologica at Naples, or the Marine Biological Laboratory at Woods Hole, although neither is exactly parallel. A modern industrial-based "think tank" may be close but also not entirely analogous.

Delaroche (1811) wrote on two parasites that he found on fish gills at Majorca in the western Mediterranean; one of these parasites was a true flatworm (the monogenean *Polystomia thynni*); the other was a "lernaeid," to which Delaroche gave the name *Chondracanthus*, from the cartilaginous sort of spines over the body. Delaroche found the copepod on the gills of the dory, *Zeus faber*, and named the new genus and species *Chondracanthus zei*. His figures indicate dorsal and ventral views of a female, showing the spiny projections. Brian (1906) said that Delaroche had a second copepod species, *C. thynni*, but this was the flatworm.

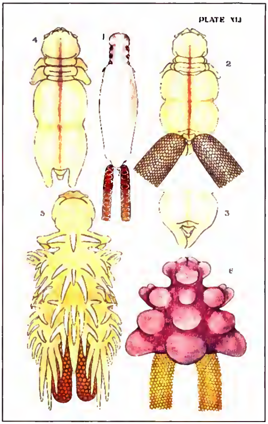
Although Delaroche was undecided where to place this 12-mm copepod in the natural order, he recognized that it was similar to *Lernaea*. He concluded, following the conventional position, that it was probably related to the intestinal worms. Indeed, the journal indexed both parasites as helminthes, even though it offered categories for insects and zoophytes.

In 1822, de Blainville, who was rather free-wheeling with nomenclature, gave the genus *Chondracanthus* a different name (*Lernacantha*). As if to make up for this, de Blainville named the type species after Delaroche (*delarochiana*). The last offense was that de Blainville said it came from a tuna (again, the flatworm!). Present-day judgment has restored the original name given by Delaroche (Kabata 1979).

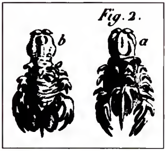
While at the Balearic Islands in the winter of 1807–1808, Delaroche and the expedition's leader experimented on air bladders of fishes at various depths. Their results were published in the *Annales du Museum d'Histoire Naturelle* in 1809. They also mixed pure gases in various proportions to see if they would combine when subjected to great pressures (to a depth of 310 m); they did not.

Back in Paris in 1809, Delaroche continued his experiments on body temperature and environment, the results of which he presented to the Academy of Sciences later that year. In 1811, he submitted a paper to the academy regarding radiant heat, and with an eye toward a prize for research on the specific heat of gases, he turned to this aspect of physics the following year. Delaroche and a collaborator were awarded the prize. Constants and ratios determined by them were used for fifty years or more in the development of several physical theories. In November 1813, with a month left of life, Delaroche submitted a paper on the effects of wind on sound propagation.

When Daniel Delaroche died in 1813 during a typhus epidemic brought back from Russia by the retreating troops, his son François was to take over the senior Delaroche's post at the Maison de Sante. However, this was not possible because the junior Delaroche had not reached the mandatory age of forty. Duméril accepted the position in name only, and François Delaroche performed the duties. However, this did not last for long, because the son, too, died of typhus at the end of the same year.



Congericola pallida *P. J. van Beneden (Fig. 1)*, Chondracanthus depressus *T. Scott (Figs. 2–4)*, C. zei *(Fig. 5), and* C. ornatus *T. Scott (Fig. 6). From Scott and Scott (1913).*



Dorsal (a) and ventral (b) views of Chondracanthus zei. *From Delaroche (1811).*

William Elford Leach

2 February 1791–25 August 1836

William Elford Leach was a bright but brief zoological flame. That he was also a man of much imagination is evident in his enigmatic genus names (Marshall and Orr 1955, Kabata 1988). A Leach legend arose about a beloved Caroline (wife, sister, or friend?) who was immortalized in the mostly acronymic isopod genera *Anilocra, Canolira, Cirolana, Conilera, Nelocira, Nerocila, Olencira,* and *Rocinela.* I only regret that they are not copepods. But note that there was not a *Caroline* Leach, the most obvious tribute. On the other hand, the awesome beauty of these isopods might be offset by the fact that they are bloodthirsty little brutes; having them as namesakes might not be a compliment! *Cirolana*

This vignette represents the Hoe Gate, Plymouth, the house in which Dr. Leach was born.

> is a good swimmer, tenacious of life, a savage devourer of fish, and not to be held in the human hand with impunity.... Leach is said to have framed [these names] without any meaning or derivation, but simply by placing in various positions the same four consonants, and interspersing vowels to suit the requirements of his ear. (Stebbing 1893)

Another notable marine biologist of the generation following Leach also believed that these genera had been fashioned of fantasy names:

> Again, I might make new words—arbitrary aggregations of vowels and consonants,—"Farson," "Toler,"—words, if words they might be called, without an etymology, and without a meaning. I do not think this would be generally acceptable, though I might plead precedent in scientific technology,—"Rocinela," "Conilera," &c. for example. (Gosse 1860)

Contemporaries of Leach said that he was "infected with the rage for new names" and was "fond of giving names of his own that no-one else knew" that were "new-fangled" (Gunther 1975). Good reason or not, the isopod tradition was carried on by Hans Jacob Hansen (1855–1936) (adding the farsons *Alcirona* and *Lanocira*) and by Robby August Kossmann (1849–1907) (*Corilana*), both of whom are prominent copepodologists from later decades.

Leach was probably the first of a long line of "museum" carcinologists. Not only was he employed by an influential institution, his interests ranged over all of the related work: collecting, exchanging, curating, cataloging, displaying, researching, and publishing.

Leach was born in Devonshire of an ancient and independent family of private fortune, the son of George Leach, a solicitor and amateur naturalist. Bate and Westwood (1863) preserved an engraving of Leach's birthplace at Hoe Gate, Plymouth; the structure itself was destroyed in the 1860s. Leach began formal studies of anatomy and chemistry at Exeter at the age of twelve. By age seventeen, he was a medical student at St. Bartholomew's Hospital in London, where he was influenced by several still respected scholars. He transferred to the Edinburgh Medical School in 1810 but actually received his M.D. from St. Andrews in 1812 (Swainson 1840, Seccombe 1909, Gunther 1980).

Leach was elected a member of the Linnean Society in 1809, the year of Darwin's birth. Youthful fervor led him into an embarrassing situation that could have had serious consequences. Apparently, the society's elections were seldom contentious, but Leach, late in 1810

> wrote to the Fellows resident in London, entreating them "if they are friends to Science and Enemies to Quackery to attend the Linnean Meeting on Tuesday next Nov. 6th for the purpose of blackballing Mr. Bullock (Proprietor of the Liverpool Museum) who by the puffs with which he daily fills the newspapers is likely to bring that hitherto respectable body into disrepute." At the meeting one of the recipients of Leach's exhortation carried a motion that the letter should be read, with the result that the meeting resolved that Leach should be reprimanded from the Chair. Thereupon the Chairman, who was Maton the founder of the Linnean Club, administered a solemn three-cornered hat rebuke to the misguided Leach, and the proprietor of the museum was elected. Before the next meeting took place some of the Fellows on further reflection considered that they had treated Leach with unnecessary severity and gave notice of motion to rescind the resolution of reprimand. Leach also sent a letter of apology to the President, disclaiming any personal enmity to Mr. Bullock and explaining that zeal for the welfare of the Society was the sole motive of his action. This letter was read at the next meeting and the resolution of reprimand was rescinded. (Gage 1938)

It is likely that Leach and his family always viewed his medical studies as a means to a naturalist's career. Even as a medical student in London, Leach assisted informally with insects at the British Museum. As soon as Leach obtained his degree, he returned to London to edit a botanical work for Joseph Banks. Leach was made an assistant at the museum, probably with Banks's sponsorship, in early 1814. Leach was the first assistant not trained as a botanist. The museum emphasis in those early days was on documents, so the professional positions were "librarians," and Leach was therefore an assistant librarian. As the collections grew and more original work was conducted, the term changed to "keeper," but not officially until 1836 (Gunther 1980). A good friend recounted that

> Dr. Leach found the zoological collections in a most disgraceful state of decay and neglect. It must here be observed, that the salaries of this institution are mostly so small, that in some cases they are insufficient for the support of gentlemen. The consequence is that, if they possess no private fortune, they are obliged to become professional authors; and thus the duties of the Museum are naturally neglected, the specimens unarranged, and very often were suffered to decay in the nameless crypts and vaults . . . where one is opened every day in the year, merely to deposit fresh subjects for decay, and to ascertain how the process has gone on during the last year. In these visits we occasionally accompanied our friend; and very frequently assisted him for hours in rummaging out and rescuing some of the more valuable subjects from that oblivion to which they were fast hastening. It is not so now, we believe; but such was the state of things when Dr. Leach took charge of our national collection. (Swainson 1840)

Leach quickly acquired a reputation as one with exceptional ability but also as one who usually disagreed with his superior's arrangements of the collections. His free-spirited and long absences more than once raised the ire of the museum administration (Gunther 1980). The long wars, just ending, had not prevented French publications from reaching England. Leach had a high regard for Latreille and Cuvier and integrated their classifications into the invertebrate collections, especially for the insects, crustaceans, and mollusks, which became his special fields. His knowledge of crustaceans may have been unsurpassed for his time.

At the first opportunity of peace, Leach was determined to go to France. He did so at least by 1815, returning in 1817 and 1818. He became friends with Latreille, de Blainville, and Cuvier. When Cuvier came to London in 1818, Leach was his host. He also worked with de Blainville in London. Leach's firsthand experiences at the Muséum d'Histoire Naturelle and the Jardin des Plantes carried significantly into the operations of the British Muséum (Gunther 1980).

Leach made far-reaching and lasting impacts on crustacean classification because of his insight and the popularity of the publications themselves. In the first years of the 1800s, the French fashion for comprehensive "encyclopedias" had spread to England; contrary to similar volumes today, these were outlets for original research. From 1813 to 1819, Leach authored a half-dozen summaries of what were then believed to be crustaceans, in Brewster's *Edinburgh Encyclopedia* and the *Encyclopedia Britannica* as well as in the seemingly interminable *Dictionnaire des Sciences Naturelles* in Paris (Vervoort 1986b). A previously unrecorded article, essentially a repetition of the Edinburgh publication, was Leach (1814) for *Rees's Encyclopedia*. Each of these articles also contributed more or less incidentally to copepod science.

Leach gave abundant credit to his predecessors, particularly Linnaeus, Geoffroy, both Fabriciuses, Müller, and Jurine. Leach's presentations came at a time when separating crustaceans from insects was still considered an innovation:

> Many collectors, either from accustomed habit, or veneration for Linne, still consider the crustacea as a branch of Entomology, and as they both agree in having articulated limbs and antennae, they are admitted by most British collectors into their cabinets as genuine *insects*; their internal structures, economy, and external appearances, being disregarded. (Leach 1814)

This ambiguity is reflected in Leach's articles in the Edinburgh and Rees compendia. Except for classifying the myriapods with the crustaceans, Leach followed Latreille rather closely, dividing the class into the orders Malacostraca and Entomostraca. By the end of the same articles, in an appendix, Leach had placed the myriapods in a class of their own and retained the isopods in the crustaceans. Leach's treatment of the higher crustaceans, the Malacostraca, was distinctly modern, and it was

with these that he had his greatest impact (Leach 1814, 1815; Desmarest 1825). Leach made no additions to the entomostracans at that time. The recognizable copepod genera were placed either in the family Pneumonura of the tribe Thecata (*Caligus* and *Argulus*) or in the family Pseudopoda of the tribe Gymnota (*Cyclops*).

Leach required a few more years before he was comfortable making changes to the entomostracans. In a landmark publication on malacostracans, Leach (1815) admitted that "the Entomostraca are but little known, and consequently their arrangement is extremely imperfect." The entomostracans, however, had now been raised to subclass status. In 1816, in the *Encyclopedia Britannica,* Leach described the new copepod genera *Anthosoma, Cecrops,* and *Pandarus* (Kabata 1979, 1988).

With the publication of his articles in the *Dictionnaire,* Leach had cemented his authority on the continent as well as at home. Latreille was the editor of these sections, and some Leach genus names in manuscript appeared in a Latreille classification first, in 1817, but without descriptions. Leach (1818) listed, also without description, "all of the genera of crustaceans that have been published to this time," including *Anthosoma, Argulus, Calanus* (not yet described), *Caligus, Cecrops, Cyclops, Dichelesthium, Ozolus* Latreille, 1802 (= *Argulus*), and *Pandarus.* Leach reviewed early classifications of crustaceans but offered nothing new.

In a companion article specifically dealing with the entomostracans, Leach (1819) made the point that their classification within the crustaceans, as introduced by Müller, was an artificial scheme. Leach's perspective, an obvious reflection of where the efforts had been placed, was that "all entomostracans are aquatic: some of them are marine; but the greatest number, by far, live in fresh water" (Leach 1819). In the decades that followed, the great explorations of the seas would dispel this notion.

Following Latreille's 1817 classification, Leach (1819) grouped and defined, but did not illustrate, the known copepod species, and he boldly added a few more of his own:

Class Crustacea
  Subclass Entomostraca
    Order I. Poecilopoda (front feet for walking or grasping, hind feet for swimming)
      1st Family. Argulidae (*Argulus* = *Ozolus, Binoculus*), with a review of André Jurine's work on morphology and metamorphosis of *Argulus*
      2nd Family. Caligidae
        1. *Anthosoma smithi* Leach, 1816 (= *Caligus imbricatus* Risso, 1816)[7]
        2. *Dichelesthium sturionis* Hermann
        3. *Cecrops* Leach, 1816. Found by Latreille on the gills of common turbot.
        4. *Pandarus bosci* Leach, 1816. Found on the English coast.
        5. *Pandarus bicolor* Leach, 1816. Found on common sharks of English seas.

The last two species are considered synonymous (Kabata 1979).

        6. *Pandarus carchariae* Leach, new species. Taken from the requiem shark.
        7. *Pandarus cranchi* Leach, new species. Found by Cranch on the expedition to discover the source of the River Zaire. Specimen from the Gulf of Guinea (Monod 1970).
        8. *Nogaus latreillii* Leach, new genus and species. Also found by Cranch, in the Gulf of Guinea. This is prob-

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[7] Leach found this on a shark on the Devonshire coast and compared it to specimens that Risso had taken from a shark at Nice and sent to Latreille. It is now *A. crassum* (Abildgaard, 1794) (see Kabata 1979).

ably a composite species; the genus is ill-defined, and remains uncertain (Kabata 1979).

9. *Caligus mulleri* Leach, 1816. This is considered identical to *Caligus curtus* Müller, 1785 (see Brian 1906, Kabata 1979).

10. *Risculus molvae* Leach, new genus and species. Found attached to a codfish. This is now *Caligus molvae* (Leach, 1819) (see Margolis, Kabata, and Parker 1975).

Order II. Phyllopoda (front feet like antennae, terminating in long setae; hind feet for swimming) [no copepods]

Order III. Lophyropa (all feet for swimming)

1st Family. Cyclopidae

1. *Cyclops vulgaris* Leach, new species. However, Leach indicated that this was the same as *Cyclops quadricornis* Müller. "Found in stagnant water; very common in France, Germany, and England."

2. *Calanus finmarchicus* (Gunnerus, 1770), by reference to Müller (1776) who in turn referenced Gunnerus; Leach, new genus.[8]

Order IV. Branchiopoda (stalked eyes; all feet for swimming) [no copepods]

* * *

Mention of "Cranch's Expedition" requires a short aside. John Cranch (1785–1816) was a shoemaker turned zoologist on an expedition sent to West Africa to ascertain if the large river from the Congo (the Congo or Zaire River) was the same as the Niger recently discovered from inland (Monod 1970). Captain James K. Tuckey (1776–1816) commanded the Royal Navy sloop *Congo*. A small party of naturalists, including Cranch and the Norwegian botanist/geologist Christen Smith (1785–1816), gave the expedition its scientific aspect. Soon after the expedition left England in March 1816, Captain Tuckey noted in his log that "the Naturalists became most grievously sea-sick," a phenomenon to which I can easily relate. However, the mal de mer was of small consequence compared to illnesses to come, as the reader may already have surmised by the just-noted common dates.

Cranch was the first marine biologist in the Gulf of Guinea (Monod 1970). His use of a "small net" always suspended over the ship's side coincides with the year that J. V. Thompson first used plankton nets. However, Cranch's organisms were generally larger than copepod-sizes, so that his net was probably not of small mesh.

With a bottle, Cranch collected "several Crustaceous Insects, 2 are nearly allied if not *Monoculi*" (Monod 1970). In the Gulf of Guinea, Tuckey recorded that

> I have no doubt but the marine entomologist would here be able to add immensely to this branch of natural history. As it was found impossible to preserve the far greater number of these animals by reason of their delicate organization, the spirit of wine dissolving some, and extracting the colours of others, and as most of them require the aid of a microscope to describe them, a great portion of them were lost on us, from the want of a person either to describe or draw them from that instrument. (Monod 1970)

Cranch's journal recorded that

> The sea was extremely luminous this night with a small species of *Crustacea* a few of which are presd. & Dr Smith made a drawing from them. . . . This & the 2 preceeding nights the sea has been extremely luminous arrising principly from myriads of *Crustacea* which rise on its surface at night. . . . A few stormy Petrels were the only birds we saw this day. (Monod 1970)

The sloop went about fifty miles upriver in the Congo, where Cranch died on 4 September, most certainly of one or more of the infamous tropical fevers. Among his effects were nine quires of paper and a looking glass. Cranch had clear merit as an artist and an observer and would have made significant contributions if he had survived. He and another naturalist, who had died a few days before Cranch, were buried in a local king's cemetery. Smith, who had been referred to in Cranch's journal as "my friend and companion," died 22 September, but he was immersed in the river. Captain Tuckey died on 4 October. This was the effective end of the expedition to the Congo, although, in spite of the disastrous outcome in the field, many valuable specimens were brought back to Leach at the British Museum (Monod 1970).

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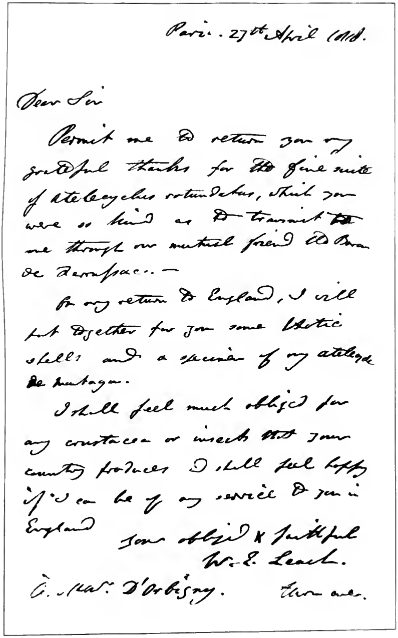
[8] Leach noted only that members of this new genus have two antennae and a single eye. The species is from "Finmark's sea." If this were done in a similar fashion today, it would likely end the author's career. But in view of the collective "relative" descriptions, it was barely adequate to define alongside the other species.

This is the source, then, of the exotic copepods described by Leach. Cranch and Smith were memorialized in two of Leach's copepod species. Leach also described many birds from this voyage and, as a consequence, one of the storm petrels, which sailors know as Mother Carey's chickens, the harbingers of rough seas, is known to this day as Leach's storm petrel.



Paris. 27th April 1818.

Dear Sir

Permit me to return you my grateful thanks for the fine suite of Atelecyclus rotundatus, which you were so kind as to transmit to me through our mutual friend the Baron de Ferussac.—

On my return to England, I will put together for you some British shells and a specimen of my atelecycle de Montagu.

I shall feel much obliged for any crustacea or insects that your country produces. I shall feel happy if I can be of any service to you in England

Your obliged & faithful
W. E. Leach.

À Mons. D'Orbigny. Esnandes.

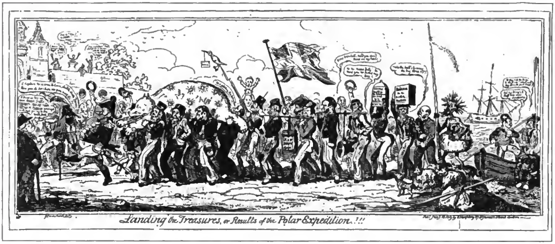
Leach letter of 27 April 1818 to the precocious French naturalist Alcide D'Orbigny (1802–1857). Courtesy of the Wellcome Institute Library, London.

* * *

Leach's strange and now famous name "*Calanus*" has been subject to much conjecture. It also suffers from a variety of pronunciations; Giesbrecht (1892) felt obliged to footnote "sprich: Cala'nus." A taxonomist does not have to have a "reason" to make a genus name from a real or imagined model from antiquity; there are many examples within the copepods: *Aegisthus, Clytemnestra, Cyclops, Euryte, Euterpina, Idomene, Lernaea, Therodamas,* etc. (see also Kabata 1988). Marshall and Orr (1955) had an ingenious possible origin for Leach's "*Calanus,*" and this was elaborated upon by Kabata (1988). Durant (1954) said that Calanus was an Indian philosopher who practiced an ascetic meditation known as *yoga* and followed Alexander the Great to Persia. Becoming ill and preferring death to long suffering, he mounted a funeral pyre and burned to death without a sound, to the astonishment of the Greeks—not to mention our astonishment at the connection that Leach may have made to this strange person. Perhaps, as Marshall and Orr (1955) indicated, the relaxed copepod might have suggested a *yogi* attitude familiar to the old philosopher.

Calanus might more easily have commenced as a typographical error. If it was merely a slip of the pen (and intended as "calamus," meaning a pen or quill of a feather), Leach had ample opportunity to correct it but did not. Bate and Westwood (1863), working with Leach's labels, referred to "Mr. Leach's peculiar handwriting." I have included an 1818 Leach letter from Paris, which is not in an extraordinarily bad hand. In fact, all words are legible. But perhaps a typesetter, facing an entirely new word, could have turned an "m" into an "n." Maybe Leach enjoyed bewildering his colleagues. If so, it was not the first time, nor the last, that a name appeared unaccompanied by parentage.

As a reflection of the high regard in which Leach was held both at home and abroad, he was made a Fellow of the Royal Society in 1817. He was also a member of other groups in England, France, and


Landing the Treasures, or Results of the Polar Expedition.!!!

Cartoon by George Cruikshank, 1819, depicting the landing of the treasures from Ross's Polar Expedition. Leach is sketched jumping on the ramparts of the old British Museum building. Courtesy of the British Museum (Natural History) and A. E. Gunther.

America. It was said that Leach tried to do singlehandedly at the British Museum what several professors were doing at the Muséum d'Histoire Naturelle and that this pace led to his illness:

> Well do we remember the time when he set to work manfully in cleaning out what was then an Augean stable—a chaos of "confusion worse confounded." But the efforts of long years of misrule and of disorder were not to be overcome by a single individual, who, while he was stopping the plague in one quarter, was necessitated to permit its full rage in another. Duties which, to be performed, would have required the activity of five or six naturalists, were imposed upon one; the task was Herculean, and, as his friends foresaw, he sunk under their burthen. (Swainson 1834)

In July 1820, Leach asked for a leave of absence; when he resigned in March 1822, he had already left England for the sake of his health. The museum trustees voted Leach a pension and paid him outright for the large collections he had left behind. In spite of devoted care by his only sister, Jenny, Leach died of cholera in 1836, near Tortona in northern Italy (Gunther 1980).

Even though he was only seven years at the British Museum, Leach's legacy, personal and published, lived far beyond that short span. His premature departure delayed the career of his protégé John Edward Gray (1800–1875). No other zoologist was to have a greater influence than Gray on the museum (Gunther 1980). Gray provided what otherwise would have been a direct connection between his "friend and tutor" Leach and the British carcinologists of the rising generation: Baird, Johnston, Lubbock, Norman, Charles Spence Bate (1818–1889), and Westwood (Bate and Westwood 1863, Seccombe 1909, Gunther 1975). Many Leach specimens were not described for fifty years or more. Leach's synopsis of British mollusks was not published until 1860.

There have been numerous and sincere tributes to Leach's inspiring strengths. J. V. Thompson (1830) said that Leach was "the first Crustaceologist in Europe, and of the most scrupulous exactness," possessing "that uncommon foresight for which he is distinguished." Another who memorialized Leach said that his "knowledge of the Crustacea was superior to that of any other naturalist of his time, and his arrangement the best, until the work of Dr. Milne Edwards appeared two years ago" (Anon. 1837). Milne Edwards (1834) asserted that he himself owed Leach the highest obligations. Johnston (1847) described

Detail from cartoon.

Leach as "a naturalist of most indomitable enthusiasm and very extraordinary acquirements."

Gunther (1980) said that there was no known portrait of Leach. However, I offer the following story: In 1819, shortly before Leach first became ill, John Ross returned from the Parry Arctic Expedition with a large collection of zoological treasures (Rice 1975). Such an event is easily parodied by those who have no sympathy for "bug collectors." One of the best caricaturists of all time was George Cruikshank (1792–1878), who immediately lampooned the expedition in the popular press. The resulting cartoon is crowded with mockery. At the head of the procession is John Ross, whose eighteen-year-old nephew James Clark Ross is helping support the trophy polar bear. Captain Sabine (later president of the Royal Society) hoists a gull *Larus sabini* on his bayonet. None in the procession retain nose or toes, having lost them to frostbite. "Jack Frost" is carrying a "Lance made of Horn of ye Sea Unicorn, used in common, as a walking stick" and mistaken as the actual North Pole. A respectable citizen comments that "I think as how we have *Bears, Gulls, Savages, Chump wood, Stones* & *Puppies* enough without going to the North Pole for *them*."

The good ship *Isabella* awaits at anchor, with a broom attached to the mast—the traditional "boat for sale" sign. In the distance is the old British Museum at Montagu House. On the wall, at the top of a ladder, is a good likeness of Joseph Banks. Next to him, a thin agitated figure shouts, "I see it! I see it! The North Pole by Jupiter!! I'll cling to it like a *leech*. Huzza! huzza!!! huzza!" This is William Elford Leach.

How realistic is this "portrait"? Leach's colleague Swainson, who "in the year 1817 . . . first had the gratification of making his acquaintance [that] soon sprang up into great intimacy," described Leach:

> Of a slight form, and delicate habit, it soon became evident to his friends he was overworking himself. His habits became irregular; he studied during the night, instead of the day; and although much attached to gymnastic exercises, they were violent, uncertain, and not such as would operate gently and effectually on a naturally nervous and irritable temperament. One of these, for instance, was leaping over the back of a stuffed zebra . . . over which we have seen him vault with the lightness of a harlequin. In his conversation, he was particularly animated, and even witty. In his own apartments he had two little rooms—one containing a collection of skulls, the other of bats; these he designated as his Scullery and his Battery. He was so remarkably active, when in health, that we have seen him leap up that long flight of steps, constituting the present grand staircase, taking three or four at a bound, and getting to the top, while an ordinary person would have scarcely left the bottom. It was, if we remember correctly, about the year 1821, that we first remarked an evident change in his health: he had become paler and thinner than usual—highly nervous—and his eyes shone with that unnatural brightness so indicative of the fearful affliction which soon after became apparent to every one, and rendered the care of his friends absolutely essential to his welfare. This event, of course, terminated his public life at the British Museum. Removed from that exciting cause, and retired in the country, his mind became more calm; and he soon sufficiently recovered to undertake a journey on the Continent, where he ever afterwards resided. . . . Although his physicians ever after prohibited him from

This vignette represents a sketch made by Dr. Walker of a jetty at New Brighton on the Mersey.

> close attention to his favourite pursuits, he still occasionally collected specimens for his friends. His name will be long cherished by those who remember his warm, frank, and generous disposition; and will ever rank high in the science of this country. (Swainson 1840)

If I had an ability to sketch Leach from this description, he would look like this small Cruikshank "portrait," perhaps having just vaulted the zebra. You can be the judge.

* * *

No conspicuous copepodological event occurred in the 1810 era to conveniently break this narrative. In both the first and second decades of the nineteenth century, there were mixtures of short descriptions from new field work and longer discourses about the nature of copepods based on literature and thought. At first Bosc, with his summary of crustacean knowledge, was preeminent against the background of Lamarck's and Latreille's more detailed activities. Then Leach, in particular, made notable advances both in the field and the library and, for crustaceans, dominated the second decade. The next chapter will conclude the second decade, highlighting two of our forerunners who were among the best examples of early field biologists, Risso and Say. We also consider the mostly cerebral contributions of their famous contemporaries, Rafinesque and Oken.

11

INTERROGATING NATURE

> It is in private, it is in shelter from the tumult of towns and political storms, it is in the field finally where one goes to interrogate Nature; it is to her we respond with willingness, and we open her heart to satisfy our curiosity.
>
> —Jurine, *Histoire des Monocles*

Wilhelm Gottlob Tilesius von Tilenau

17 July 1769–17 May 1857

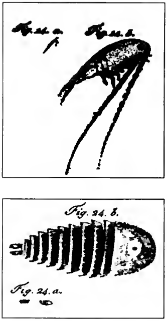


Fig. 24. b.
Fig. 24. a.

Two copepods, a juvenile calanid (Fig. 14) and a sapphirinid (Fig. 24), drawn by Tilesius (1813) for the Atlas *of Krusenstern's voyage around the world.*

Wilhelm Gottlob Tilesius, zoologist and artist, was born in Muhlhausen, Thuringia, Germany, between Cassel and Leipzig. Although he also spent his last day at this place, Tilesius was not rooted to the spot. In fact, he managed a zoological excursion around the world (1803–1806), accompanying Adam Johann von Krusenstern (1770–1846) on the first Russian circumnavigation (Hagen 1863, Økland 1955). For his contributions to Krusenstern's expedition, Czar Alexander I ennobled Tilesius with the title "von Tilenau" (Carus 1872).

Tilesius studied medicine in Leipzig and expressed his remarkable talent for drawing excellent figures of rare animals and plants. After earning his doctorate, he went into the Russian civil service as a privy councillor and joined Krusenstern (Hess 1894).

For copepodology, Tilesius had three minor contributions, which sadly have been neglected even by Russian workers. The larger report (Tilesius 1815) was based on the Krusenstern explorations and published in the memoirs of the Imperial Academy of Sciences at St. Petersburg: "The Kamchatka Crustacea, microscopic marine bioluminescent isopods, entomostracans, and shrimps." The *Atlas* of Krusenstern's voyage included two Tilesius (1813) copepods, a juvenile calanid and a sapphirinid. About the only student who gave Tilesius credit for his copepod work was, unsurprisingly, Baird (1850). Baird said that Tilesius's *Cyclops inermis* is the same as *Canthocamptus minuticornis* (Müller, 1785); Lang (1948) believed that both species were unidentifiable. Baird thought that Tilesius's *Cyclops armatus* was *Harpacticus chelifer* (Müller, 1776), but Lang again felt that Tilesius's species was unidentifiable. Tilesius cited the work of Jurine and Ramdohr who showed that Müller's nauplius was a stage in the metamorphosis of *Cyclops*.

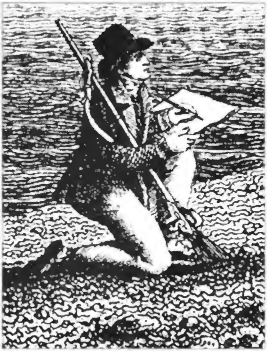
Tilesius (1815) recorded both of Müller's *Caligus* species, *C. curtus* and *C. productus*. Tilesius's Kamchatka caligids were from salmon, but he also reported them on dolphin fish and sharks from Brazil (Margolis, Kabata, and Parker 1975).

Tilesius published two shorter papers, also on marine bioluminescent animals, including copepods, in 1814 and 1818 (see Vervoort 1988). He filled his later years as a Hofrath (honored councillor) and Professor of Natural History at the University of Leipzig (Hagen 1863), and apparently also at Göttingen and Dresden (Hess 1894). Agassiz (1854) listed over twenty Tilesius papers (1801–1826) on fish, whales, invertebrates, and a Siberian mammoth skeleton from as far afield as Kamchatka, Australia, Brazil, and Japan. There is also a two hundred-page list of fish and crabs from the Adriatic that Tilesius published in 1796.

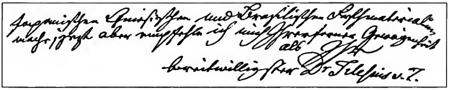
The National Library of Medicine (Bethesda) catalogs eight Tilesius papers on medical topics from 1793 to 1831. Tilesius had an early interest in diseases, and after 1830 he returned to medical subjects. He published some papers on the Asiatic cholera that was gravely threatening Europe at the time. We have already mentioned this disease in the demise of Cuvier and Leach, and it will be mentioned again in Chapter 13, together with a surprising copepod connection.

In 1837, the young Michael Sars (1805–1869), not yet a published copepodologist, was touring the zoological centers of France and Germany. While Sars was inspecting mollusks in the museum at Dresden, Tilesius walked in. In greeting Sars as an old friend of Sars's host, this "senior among the naturalists" kissed Sars "in the German manner" (Økland 1955).

In some old publications there are figures engraved as drawn, rather than in mirror image (which is more difficult to engrave). The *printed image*, then, would be a mirror image of the original, which can be misleading for asymmetrical objects. (In some cases, these figures have been engraved anew, with the same carelessness, resulting in two wrongs making a right.) I believe that the accompanying self-portrait of Tilesius (1813) was incorrectly engraved in this manner. I have, therefore, with the aid of modern computer technology, turned it into a mirror image. The flint-lock of Tilesius's firearm is now on the correct (safe) side, and we can see that he must have been left-handed!



Self-portrait of Wilhelm Gottlob Tilesius (1769–1857) in the Atlas ***of Krusenstern's voyage around the world. From Tilesius (1813); signature courtesy of Senckenberg Museum, Frankfurt.***



[illegible]
mehr jetzt aber empfehle ich mich Ihrer ferneren Gewogenheit
als Ihr
bereitwilligster Dr Tilesius v. T.

Constantine Samuel Rafinesque

22 October 1783–18 September 1840

Rafinesque was a most unnatural naturalist; looking back on his works, one must either love him or hate him. Nearly every one of his over nine hundred publications is rare, and he is not generally well known. It would be difficult to find another who published so much and so consistently in obscure places and in fugitive journals.

Constantine Samuel Rafinesque, or as he used in his early life, Rafinesque-Schmaltz, was born in Constantinople, Turkey, into a cosmopolitan French-German family. He had an early interest in botany, which he applied in observing the plants of Delaware and Pennsylvania while in the United States from 1802 to 1804. Rafinesque lived in Palermo, Sicily, from 1805 until 1815 and privately published several amazingly comprehensive natural history essays based on his observations there.

One of the Palermo publications (Rafinesque 1815) contained the bulk of his thoughts on crustaceans. This was the "Analyses of Nature or Table of the Universe and Organic Bodies," a "rough sketch of a vast plan dedicated to the friends of Nature and to noble friends who appreciate the study of the universe and of the creatures gifted with life." Rafinesque acknowledged no formal teachers: "No one encouraged my work. . . . With zeal and ardor I pursued my work scornful of envy and without fear of rivals. . . . Nature is my guide, and Linnaeus is my master" (Rafinesque 1815). We might say now that Rafinesque had an attitude problem. If he had been born a century earlier, he could have worked on a clean slate instead of ignoring his contemporaries. If he had been born a century later, in a more structured world, perhaps his energies and genius would have been better channeled.

To dwell on Rafinesque's arcane and stillborn classification would derail the narrative. Suffice it to say that Rafinesque's system had no influence, and nearly all of his introduced crustacean names were without adequate description and have no taxonomic status (Holthuis 1954). The early natural-

C. S. RAFINESQUE—SCHMALTZ SOMIOLOG. N. 22. OCT. 1783.

C. S. Rafinesque

Constantine Samuel Rafinesque (1783–1840). From Merrill (1944); signature from Adler (1989).

ists who were able to consult Rafinesque's obscure crustacean papers found so much that was scanty, unillustrated, and just plain wrong that his entire output was rejected. In retrospect, this was unjust, but it is clear that Rafinesque's work did not measure up to the increasing standards of his contemporaries.

Within an entirely new crustacean classification, Rafinesque (1815) acknowledged the established (copepod) genera *Caligus* and *Cyclops* but needlessly resurrected Müller's misinterpreted *Amymone* and *Nauplius*. He listed, but did not describe, several genera now condemned and forgotten: *Agastor, Aonitus, Bronteus, Calais, Cladeus, Clavilia, Godeus, Slaberius,* and *Zeteus*. Two Rafinesque species were also dead on arrival: *Cyclops obtusicanda* and *C. serratus*. In the 1817 second volume of the obscure *American Monthly Magazine of Critical Review*, Rafinesque mentioned another new copepod genus, *Daphinia*, that Wilson (1924) charitably believed might be *Calanus*. If so, and if Rafinesque had adequately defined the genus, *Daphinia* would have preceded *Calanus* by two years, causing copepodologists endless confusion of the name with the most common cladoceran *Daphnia*.

In addition to the recognized crustaceans, Rafinesque, following some contemporaries, included the lernaeids in the class of soft mollusks. Beside the genus *Lernaea* were six unclothed names: *Dotona, Melanippa, Iphitus, Zeuxonia, Clytiana,* and *Etione*. Presumably these were also parasitic copepods, now only historical curiosities.

Rafinesque returned to the United States for the last half of his life. His autobiography from 1836, rescued from obscurity by Merrill (1944), recounts Rafinesque's life of travels—"a voyager from the cradle, I will be so until the grave." Long preferring botany over the bloodletting of zoology and anatomy, Rafinesque covered the bulk of the new United States on many extended botanical "walks." He seemed always to gravitate to the most interesting aspects of nature and to the most interesting people. His correspondents and acquaintances were legion. On the whole, I found him believable and sympathetic. He was nothing if not earnest; the inability to focus was his undoing. Even Asa Gray (1810–1888), a severe critic while Rafinesque lived, said ever afterward that Rafinesque's botany had not been treated fairly.

In backwoods Lexington, Kentucky, Rafinesque became Professor of Natural History for Transylvania University and was surrounded by a little studied nature. What relatively positive, though short-lived, reputation the quaint university had was due largely to Rafinesque, who was there from 1819 to 1826:

> For a parallel to its anomalous, exotic growth in the forest primeval, one would have, I suppose, to go back to some medieval German university set in the forest, ruled by the clergy, supported upon a superstitious peasantry and somewhat scornfully attended by the petty nobility. A Dr. Faustus, dangerously experimenting, tempting the rack or devil-ridden madness, would correspond in a crude way to Rafinesque.

> Every few years some one, within the realms of natural history or without them, re-discovers Rafinesque. He has been the most widely celebrated unknown man in science, equaling in brilliant obscurity Roger Bacon or Paracelsus. . . . As a universal genius of every branch of science, Rafinesque ranks with Humboldt; he dabbled in more fields than even Réaumur, and it is plainly impossible for any one scientist to estimate the worth of this incredible fellow. . . .

> But he had no mental discipline, no capacity to see any subject through to a conclusion, no respect for the work of others, no care for how he wounded feelings or made enemies, and absolutely no sense of humor. He . . . failed at everything in life—and somehow remains greater far than the men who jeered at him. . . . When Rafinesque took the chair of natural history at Transylvania he was already the author of some two hundred and fifty unread books and articles, an absentee member of a score of [the] most learned societies of Europe and America, and an unrecognized authority on Mediterranean marine zoology. Cuvier had blasted his reputation because in the pickled specimens of Sicilian fishes he dissected he could not see the iridescent beauty Rafinesque described. Of his foreign fame the students knew nothing. . . . To them he was only a comical, whimsical foreigner. (Peattie 1938)

Like Rafinesque's other enterprises, the stint in Kentucky came to a bad end:

> I returned to Lexington by the Ridge road, and proceeded to Frankford, when I found how the President of the University had behaved in my absence. To evince his hatred against sciences and discoveries, he had broken open my rooms, given one to the students, and thrown all my effects, books and collections in a heap in the other. He had also deprived me of my situation as Librarian and my board in the College. . . . I took lodgings in town and carried there all my effects: thus leaving the College with curses on it and [President] Holley; who were both reached by them soon after, since he died next year at sea of the Yellow fever, caught at New Orleans, having been driven from Lexington by public opinion: and the College has been burnt in 1828 with all its contents. (Rafinesque, qtd. in Merrill 1944)

Agassiz (1854) listed twenty-seven Rafinesque publications—mostly of a general, all-encompassing disposition—with some papers specific to groups such as fish and mollusks. Probably Rafinesque's most influential publications were the rare *Ichthyologia Ohioensis* of 1820 and a monograph on medicinal plants of the United States from 1828–1830.

Those who knew Rafinesque personally, men like Audubon, considered him erratic, perhaps even unbalanced (Herrick 1938). He certainly was not a good agent of his own work. The publishing committee for the first volume of the *Journal of the Academy of Natural Sciences of Philadelphia* felt compelled to disavow Rafinesque's publication on a new fish species that he had previously described elsewhere under a different name. Such an unpardonable offense has been committed by many before and since, but the implication here is that Rafinesque was aware of his misdeed.

Rafinesque mentioned in his autobiography that "I had some intention to join Mr. Maclure at New Harmony, but he had friends jealous of me also: it was well for me, since his views and fine College have been abortive" (Rafinesque, qtd. in Merrill 1944). In summarizing his quixotic life, Rafinesque said that

> I have tryed to serve mankind; but have often met with ungrateful returns. I have tryed to enlarge the limits of knowledge; but have often met with jealous rivals instead of friends. I have tryed to instruct and enlighten by my writings; but my pen has often been snatched or compelled to be idle for awhile. . . . With a greater fortune, or if I had not lost my estate several times by revolutions and shipwreck, I might have imitated the Humboldt, Linnaeus, Pallas. . . . But I have had friends and I have several yet: they know my zeal and steady efforts. . . . If I have often gone beyond the actual state of knowledge in my views and opinions, or anticipated on future knowledge, it was with noble aim of adding my mite to the mental improvement of mankind. If my discoveries and projects have not been speedily admitted, I leave them as a Legacy to those superior minds who will be able to appreciate them, and bestow me the justice often denyed in my days: to the friends of useful sciences, of virtue and peace, to the wise Philanthropists, to the enlightened liberal and impartial men of both hemispheres. (Rafinesque, qtd. in Merrill 1944)

Death found Rafinesque in poverty and isolation in Philadelphia. He was buried in a potter's field and his collections and books were sold as junk.

Lorenz Oken

1 August 1779–11 August 1851

Lorenz Oken had a tremendous impact on biological thinking, or rather speculation, in the early part of the nineteenth century. He left us with two good copepod genus names, and he came close to a decent understanding of the relationships of the parasitic copepods to the entomostracans, but as far as classification in general, and truly new observations, Oken's work was a sideline.

Oken was born in Bohlsbach, near Offenburg (in Baden, Germany, southeast of Strasbourg). Coming from the family of Okenfuss meant more to his life status in his time than in ours. Undoubtedly, he had

Lorenz Oken (1779–1851). From Ilomets (1976); signature from Brauning-Oktavio (1959).

much to overcome besides his congenital poverty and peasant roots. To his credit, he rose to the peak of professorial and scientific ranks.

Oken had his first instruction from teachers and preachers in his village. In 1793, after the death of his parents, he went to the Franciscan Gymnasium in Offenburg where he stayed until 1798. Oken attended the School of the Cathedral in Baden for the next year and then enrolled at the University of Freiburg as a medical student and for his initial exposure to influential persons. His greatest interests at the university were in philosophy and natural history, and he was determined not to have an actual career in medicine. He obtained an M.D. in 1804 (Lang 1887).

Oken, as early as 1802, published an "Outline of the Systems of Natural Philosophy." He was to spend his life perfecting this "system." In 1804, Oken went to the University of Würzberg and studied under the anatomy professor Ignaz Döllinger (1770–1841), himself a follower of Friedrich Schelling (1775–1854), philosophy professor at Würzberg (Brauning-Oktavio 1959). (Döllinger's most famous pupils there were likely his own son, who was a theologian; Karl Ernst von Baer; and Oken.)

After some travel, and a short time at Göttingen, Oken was named as an Extraordinary Professor (assistant professor) of Medicine at the University of Jena in 1807. Oken was very outspoken in his political beliefs, which leaned toward the revolutionary unification of Germany, and so was under suspicion by the authorities. He also had a personal falling out with Johann Wolfgang Goethe (1749–1832) over an arcane anatomical theory, and thereafter his days in Jena were numbered (Brauning-Oktavio 1959). He was forced to resign in 1819.

After a decade as professor in Munich, Oken, hounded by the same difficulties he had experienced at Jena, accepted a professorship in natural history at Zurich, where he remained, contented and respected (if not esteemed), until the end of his years (Nordenskiold 1928).

Oken was a linchpin in the charismatic "Natural Philosophy" movement that was especially vigorous in Germany and Scandinavia. If Emmanuel Kant (1724–1804) and Schelling were the saints of Naturphilosophie, then Oken was the high priest. In this school there was interminable discussion of the relation between the perceptions of things (including organisms) and the reality of those things. The goal was a system that incorporated all facts necessary to explain nature. Oken summarized these beliefs in several all-encompassing textbooks. His books were well received and raised interest in natural history, but they remained essentially fantasy (Lang 1887, Nordenskiold 1928, Singer 1959). Some adherents of natural history were lifelong proponents of natural philosophy, but most exact scientists found only temporary refuge in the field.

Oken considered his best work to be the three-volume *Lehrbuch der Naturphilosophie*, from 1809–1811. A measure of its longevity and influence is seen in its condensation published by the Ray Society as *Elements of Physiophilosophy* in 1847. I obtained a copy of this book while a graduate student but could see no relevance to anything in my life at the time. I later sold the book and now regret not having it at hand just as a curiosity. The whole thing depicts what Oken would prefer Nature to be rather than what it is. It is Nature based on mystical tiers of numbers and spheres. Oken insisted on symmetry of system; he was infuriated by Cuvier's truncated classifications, where some groups had few organisms while others had many (Winsor 1976b). If Oken had four genera in one tribe, he would have four in the alternate tribe, perhaps even if this required some injudicious repetitions.

In *Naturphilosophie*, Oken unsurprisingly placed man at the top of everything. Since other animals are perceived by way of man's perfected five senses, it stands to reason that the other animals were arrested somewhere along this path to perfection. Each class of animals, then, would be represented by the highest grade of sense that they reached. I will spare you the long-forgotten Latin names of the five classes of animals. The classes themselves are the invertebrates (feeling is the principal sense), fishes (taste perception), reptiles (odor perception), birds (sound perception), and mammals (all senses perfect, with sight the principal). There is not much to recommend this classification, other than it anticipates an evolutionary process. Oken seemed more interested in his method than in actual truths around him (Singer 1959).

Oken confronted parasitic copepods in his 1815–1816 *Lehrbuch der Naturgeschichte*, dedicated to the late Schrank (and two others) "of the immortal, venerable, and wise of the first naturalists of Germany." In the course of publication, he seems to have changed his mind with respect to the classification of these parasites. His first system placed these bizarre species with worms, in a tribe called "quill-flukes," and listed the genera *Lernaea* and *Schisturus*. The first genus included Lernaea branchialis Linnaeus and a new species *L. diodontis*, the pennellid species noticed by La Martiniere. The other fifteen nominal *Lernaea* species known to Oken were placed in a new genus *Schisturus*. Except for the fickleness of fate, *Schisturus* would have persisted; it is all but forgotten now, in favor of the later *Haemobaphes* of Steenstrup and Lütken (Kabata 1979). Similarly, Oken listed *Schisturus salmoneus*, which was an earlier Linnaean species, now *Salmincola salmoneus* (Linnaeus, 1758) (see Kabata 1979). Other generic names have also ridden roughshod over *Schisturus*.

Later in the same *Lehrbuch*, Oken (1815) reconstructed the parasitic copepods under a separate group (guild) called "Armwürmer." The armworms were further divided into four tribes, the lernaeids, the argulids, and two tribes for barnacles. The first tribe included four genera: *Axine, Clavella, Lernaea*, and *Pennella*. *Axine*, with one species *A. bellones*, disappeared without a whimper, not least because the name had been used earlier by Abildgaard for a worm. Wilson (1924) suggested that Oken's *Axine* might be equivalent to *Naobranchia* Hesse, 1863. Oken offered *Clavella uncinata* as a replacement name for Müller's *Lernaea uncinata*, apparently recognizing that it differed from the original *Lernaea*; this is now *Clavella adunca* (Strøm), from an earlier species description unknown to Oken (Kabata 1979).

With his revised system, Oken recognized that his new species *Lernaea diodontis* was closer to the (copepod) species in Linnaeus's genus *Pennatula*. Seeing that the Linnaean name held unrelated animals, Oken coined the genus *Pennella* to include the appropriate armworms, in this case *Pennella diodontis*. Wilson (1917a) considered the species identical to *P. sagitta* (Linnaeus). Most recent workers hold it to be distinct. In spite of some taxonomic twists that included official rejection of Oken's *Lehrbuch*, because he often did not use binomial names, the old genera *Pennella* and *Clavella* are valid to this day (Kabata 1993). In Oken's revised system, the only species remaining to *Lernaea* was *L. branchialis*.

Oken's second tribe of armworms, the argulids, included the known genera *Caligus, Dichelesthium*, and *Argulus*, and a new genus *Anops*. Oken (1815) said that members of this tribe "cannot swim for lack of swimming feet . . . but, since they are found on fish, are fish-lice; they resemble Entomostraca, which, however, have swimming feet, and are nearly untiring in their movements." The only Anops species listed in Oken's text was *A. radiatus*, after Müller's *Lernaea radiata*, which Oken believed was the ancient *Oestrus marinus* as well as being equivalent to ten other previously described *Lernaea* species. Oken thus suppressed his earlier genus *Schisturus*; *Schisturus* had already been used for other animals by another author (Yamaguti 1963). In any case, this *Anops* is now a junior synonym of *Haemobaphes* (see Kabata 1979).

In summary, then, Oken is remembered for two well-known copepod genera, which he discovered from books, not nature: *Clavella* and *Pennella*. He also implied a closeness of the bizarre parasitic forms to the free-living entomostracans by classifying them alongside *Argulus* and *Caligus* species, which were then acknowledged crustaceans and held by others to be entomostracans.

Oken, therefore, in spite of his romantic speculations and foggy formulas, has a lasting place in the copepodologist's cosmography. Before we leave Oken, tribute must be paid to other examples of his lasting

ANTOINE RISSO
(Zoologiste, Botaniste et Géologiste),
Né à Nice (Piémont) le 7 Aout 1777.

Antoine Risso (1777–1845). From Monod and Hureau (1977).

influence. The Jena years allowed Oken to establish the journal *Isis*, which was of unquestioned value and popularity for thirty years (1817–1847). This journal published a wide variety of substantial scientific articles, translations, and abstracts. Agassiz (1848, 1850, 1853, 1854) contains numerous examples of articles in *Isis*.

Although not often remembered for his truly scientific contributions, Oken anticipated the nature of protozoa and of animal cells, and he made advances in embryology (Singer 1959). He emphasized the difficulty in drawing a boundary between the lowest plants and the lowest animals (Lang 1887).

Oken should likewise be remembered for his role in bringing scientists together for personal discussion, at which he must have excelled. In 1821, he began organized scientific meetings stimulated by his "lively personality and his keen interest" (Nordenskiold 1928). Out of these meetings came the First German Congress of Naturalists and Physicians, in 1822 (Lang 1887, Garrison 1914). The British Association for the Advancement of Science, from 1831, traces its roots to Oken's initiative (Singer 1959).

There can be no reservations about the direct influence Oken had with his students, who were many. Oken students of upcoming interest to us are Louis Agassiz (1807–1873) and Rudolf Albert Köl-liker (1817–1905). As is evident in a letter Agassiz wrote to his brother-in-law in 1827 regarding winter lectures that Oken would be giving at Munich, there is no doubt that Agassiz was in awe of Oken:

> The instruction in the natural sciences leaves nothing to be desired [at Munich]. . . . No lack of advantages and attractions, lodgings hardly more expensive than at Heidelberg, board equally cheap, beer plenty and good. Let all this persuade you. We shall hear Gruithuisen in popular astronomy, Schubert in general natural history, Martius in botany, Fuchs in mineralogy, Seiber in mathematics, Starke in physics, [and] Oken in everything. (Agassiz 1887)

Countless naturalists and pseudonaturalists were influenced by Oken's writings. England's monumental comparative anatomist, Richard Owen (1804–1892), said that he was a great admirer of Oken's deep thinking. Owen was the head of natural science at the British Museum from 1860 to 1884. Oken's theories of segmentation, including segmentation of the vertebrate body, misled Owen as well as Karl Ernst von Baer (1792–1876) and Johannes Müller (1801–1858). Carl Gegenbaur (1826–1903) and Ernst Haeckel (1834–1919) independently, through their teachers Kölliker and Müller, respectively, and through discussions between themselves, were much influenced by Oken's ideas. We will address these scientists again.

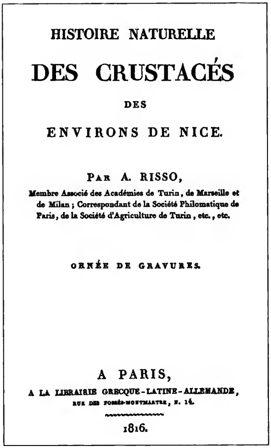
The crown of copepodology must be shared by two or three persons, the selection depending on your own interests within the wider field. Many copepod colleagues, however, would have no argument about awarding Georg Ossian Sars (1837–1927) this high-est honor; indeed, he will be prominent in our story as the nineteenth century is concluded. Oken's influence touched G. O. Sars even at the time of his birth. Sars's father, Michael Sars, a young clergyman in Norway's isolated countryside, had published a few of his earliest zoological reports in Oken's *Isis*. In early 1837, Oken wrote in review of this work and to offer encouragement to Michael Sars: "Might the energetic author come next to one of the favorable scientific places, and with his nature and his knowledge arrive at an appropriate domain, something like Christiania or Copenhagen" (Økland 1955). We will find that this is exactly what Michael Sars did.

Joseph Antoine Risso

8 March 1777–25 August 1845

Antoine Risso was not born to the good life. His father was a carpenter, and the best "schooling" the twelve-year-old Antoine could obtain was as an apothecary's apprentice. Nevertheless, the lad enjoyed and applied himself, excelling in chemical laboratory work. By 1803, Risso qualified as an independent pharmacist and followed this profession until 1826. At that time, he became an instructor in physical sciences in the Imperial Lyceum of Nice. By 1832, he occupied the Chair of Medical Chemistry at the Nice Medical and Pharmacy Preparatory School. He ended his days as Professor of Botany and Chemistry at the University of Nice. Like other naturalists of his day, Risso's interests were broad; no one knew more about the natural history of the Piedmont Region and the shores of Nice (Hagen 1863, Pilleri and Arvy 1981).

In marine science, Risso is best known for an ichthyology of Nice in 1810, a natural history of crustaceans in 1816, a comprehensive scientific regional review in 1826, and a catalog of the cephalopods of Nice in 1843. Risso was particularly fascinated by bioluminescence, as were many contemporaries. Although he had no novel theory of his own, he was satisfied in discounting most so-called explanations; at least Risso was aware of the common organisms that contributed to this phenomenon. He was also an exceptional artist, and most of his topics—particularly fish, cephalopods, mollusks, and plants—were well illustrated. Risso left a large quantity of unpublished but still preserved manuscripts (Tregouboff 1968, Pilleri and Arvy 1981).



HISTOIRE NATURELLE

DES CRUSTACÉS

DES

ENVIRONS DE NICE.

PAR A. RISSO,

Membre Associé des Académies de Turin, de Marseille et de Milan ; Correspondant de la Société Philomatique de Paris, de la Société d'Agriculture de Turin, etc., etc.

ORNÉE DE GRAVURES.

A PARIS,

A LA LIBRAIRIE GRECQUE-LATINE-ALLEMANDE,
RUE DES FOSSÉS-MONTMARTRE, N. 14.

1816.

Title page of Risso's Histoire Naturelle des Crustacés *(1816).*

Two of Risso's publications incidentally left their mark on copepod science. In the first, Risso (1816) dealt with the crustaceans of the shores of Nice. In his earlier work on fish, Risso reported certain species living to 640 m in the Gulf of Genoa. These records are among the earliest to indicate life at such depths (Merriman 1968). Similarly for crustaceans, Risso reported some species from as deep as 800 m. The little 1816 book has a distinctly modern and ecological outlook:

> It is the variety of its marine field, that gives Nice the large number of crustaceans that swarm in its waters, and that propagate in such a prodigious manner. The level sea-floor of sand and pebbles, shoals and dry crags, coves and sheltered bays, variable temperatures, and sometimes irregular depths, all contribute to bring together in these waters the immense crowds of molluscs, worms, radiates, and polyps, which furnish either the habitats or the nourishment of these animals. . . .
>
> Of all the great numbers of crustaceans on our shores, I have seen up to now 132 species which have never been described by naturalists. . . . One is enraptured with these curious creatures. . . . Continuing my zoological observations, I hope to be able to know all the new species, and I propose to publish some day a general and specific history of all the indigenous species of this part of the Mediterranean Sea that washes the feet of the maritime Alps. (Risso 1816)

Risso was aware of habitat preferences of various crustacean groups, and he saw morphological adaptations to habitat. Not only did he obtain

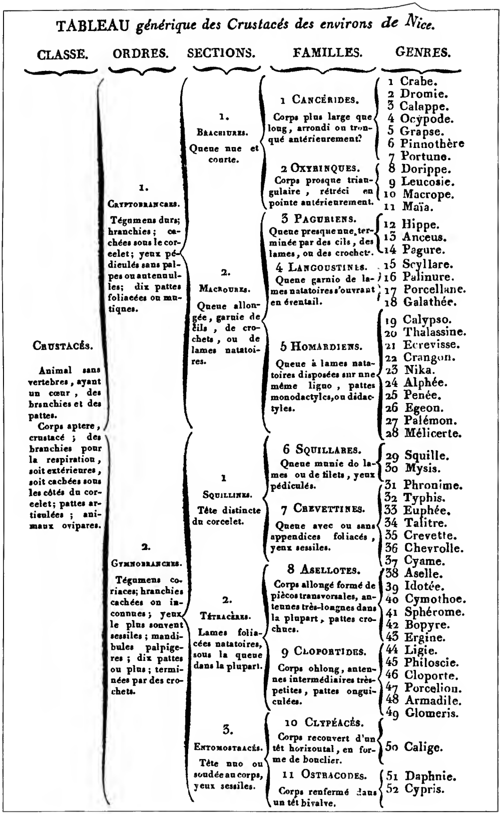
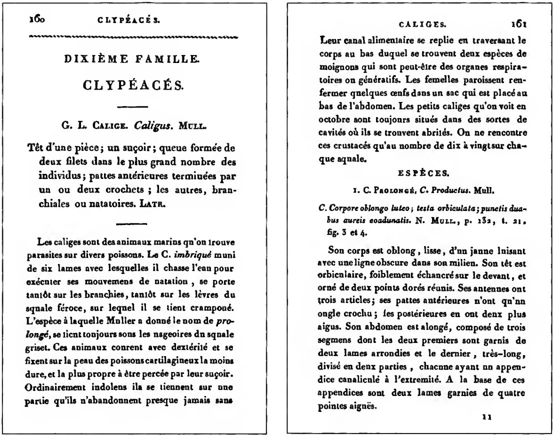


TABLEAU *générique des Crustacés des environs de Nice.*

CLASSE.	ORDRES.	SECTIONS.	FAMILLES.	GENRES.
Crustacés. Animal sans vertebres, ayant un cœur, des branchies et des pattes. Corps aptere, crustacé; des branchies pour la respiration, soit extérieures, soit cachées sous les côtés du corcelet; pattes articulées; animaux ovipares.	1. **Cryptobranches.** Tégumens durs; branchies; cachées sous le corcelet; yeux pédiculés sans palpes ou antennulles; dix pattes foliacées ou mutiques.	1. **Brachiures.** Queue nue et courte.	1 **Cancérides.** Corps plus large que long, arrondi ou tronqué antérieurement?	1 Crabe. 2 Dromie. 3 Calappe. 4 Ocÿpode. 5 Grapse. 6 Pinnothère 7 Portune.
			2 **Oxyrinques.** Corps presque triangulaire, rétréci en pointe antérieurement.	8 Dorippe. 9 Leucosie. 10 Macrope. 11 Maïa.
		2. **Macroures.** Queue allongée, garnie de cils, de crochets, ou de lames natatoires.	3 **Paguriens.** Queue presque nue, terminée par des cils, des lames, ou des crochets.	12 Hippe. 13 Anceus. 14 Pagure.
			4 **Langoustines.** Queue garnie de lames natatoires s'ouvrant en éventail.	15 Scyllare. 16 Palinure. 17 Porcellane. 18 Galathée.
			5 **Homardiens.** Queue à lames natatoires disposées sur une même ligne, pattes monodactyles, ou didactyles.	19 Calypso. 20 Thalassine. 21 Ecrevisse. 22 Crangon. 23 Nika. 24 Alphée. 25 Penée. 26 Egeon. 27 Palémon. 28 Mélicerte.
	2. **Gymnobranches.** Tégumens coriaces; branchies cachées ou inconnues; yeux le plus souvent sessiles; mandibules palpigeres; dix pattes ou plus; terminées par des crochets.	1 **Squillines.** Tête distincte du corcelet.	6 **Squillares.** Queue munie de lames ou de filets, yeux pédiculés.	29 Squille. 30 Mysis.
			7 **Crevettines.** Queue avec ou sans appendices foliacés, yeux sessiles.	31 Phronime. 32 Typhis. 33 Euphée. 34 Talitre. 35 Crevette. 36 Chevrolle. 37 Cyame.
		2. **Tétracères.** Lames foliacées natatoires, sous la queue dans la plupart.	8 **Asellotes.** Corps allongé formé de pièces transversales, antennes très-longues dans la plupart, pattes crochues.	38 Aselle. 39 Idotée. 40 Cymothoe. 41 Sphérome. 42 Bopyre. 43 Ergine.
			9 **Cloportides.** Corps oblong, antennes intermédiaires très-petites, pattes onguiculées.	44 Ligie. 45 Philoscie. 46 Cloporte. 47 Porcelion. 48 Armadile. 49 Glomeris.
		3. **Entomostracés.** Tête nue ou soudée au corps, yeux sessiles.	10 **Clypéacés.** Corps recouvert d'un têt horizontal, en forme de bouclier.	50 Calige.
			11 **Ostracodes.** Corps renfermé dans un têt bivalve.	51 Daphnie. 52 Cypris.

Table of crustacean genera. From Risso (1816).



160 CLYPÉACÉS.

DIXIÈME FAMILLE.

CLYPÉACÉS.

G. L. CALIGE. *Caligus.* MULL.

Têt d'une pièce; un suçoir; queue formée de deux filets dans le plus grand nombre des individus; pattes antérieures terminées par un ou deux crochets; les autres, branchiales ou natatoires. LATR.

Les caliges sont des animaux marins qu'on trouve parasites sur divers poissons. Le C. *imbriqué* muni de six lames avec lesquelles il chasse l'eau pour exécuter ses mouvemens de natation, se porte tantôt sur les branchies, tantôt sur les lèvres du squale féroce, sur lequel il se tient cramponé. L'espèce à laquelle Muller a donné le nom de *prolongé*, se tient toujours sous les nageoires du squale griset. Ces animaux courent avec dextérité et se fixent sur la peau des poissons cartilagineux la moins dure, et la plus propre à être percée par leur suçoir. Ordinairement indolens ils se tiennent sur une partie qu'ils n'abandonnent presque jamais sans

CALIGES. 161

Leur canal alimentaire se replie en traversant le corps au bas duquel se trouvent deux espèces de moignons qui sont peut-être des organes respiratoires ou génératifs. Les femelles paroissent renfermer quelques œufs dans un sac qui est placé au bas de l'abdomen. Les petits caliges qu'on voit en octobre sont toujours situés dans des sortes de cavités où ils se trouvent abrités. On ne rencontre ces crustacés qu'au nombre de dix à vingt sur chaque squale.

ESPÈCES.

1. C. PROLONGÉ, *C. Productus.* Mull.

C. Corpore oblongo luteo; testa orbiculata; punctis duabus aureis coadunatis. N. MULL., p. 132, t. 21, fig. 3 et 4.

Son corps est oblong, lisse, d'un jaune luisant avec une ligne obscure dans son milieu. Son têt est orbiculaire, foiblement échancré sur le devant, et orné de deux points dorés réunis. Ses antennes ont trois articles; ses pattes antérieures n'ont qu'un ongle crochu; les postérieures en ont deux plus aigus. Son abdomen est alongé, composé de trois segmens dont les deux premiers sont garnis de deux lames arrondies et le dernier, très-long, divisé en deux parties, chacune ayant un appendice canaliculé à l'extrémité. A la base de ces appendices sont deux lames garnies de quatre pointes aiguës.

11

Text of Risso's Caligus. *From Risso (1816).*

specimens between 60 and 800 m, he stated that the temperature at some of these depths was a constant ten degrees.

Desmarest (1825), who reviewed Risso's classification, said more than once of the "Crustacea of Nice" that it was "printed in 1813, but published in 1816." This is a curious statement; I can see no indication in the original book that it should predate 1816.[1] Risso stated that the higher taxa were subjective and that only the species offers a solid base. He partitioned the Class Crustacea into two orders further divided and subdivided (see his "TABLEAU *générique des Crustacés des environs de Nice*"). Below the orders, the classification was essentially that of Latreille (1810). The only reported copepods were two Caligus species of the family Clypeaces. If Risso had recorded free-living copepods, they would have fit nicely into Latreille's family Gymnotes. I regret that he did not do so.

The first Risso copepod record was of Müller's *Caligus productus* from a gray shark. Risso said his measurements of length were always from the farthest point forward, and the widths were the greatest dimension from right to left. The units were a somewhat confused metric designation. In the initial entries, Risso indicated "mill." for one thousand. For example, "0.014 mill.," which literally would be simply "14," presumably millimeters. Subsequent entries dropped the "mill." and are best interpreted as being in meters; for example, C. *productus* was "length 0.032, width 0.008," or 32 by 8 mm, probably including the egg strings.

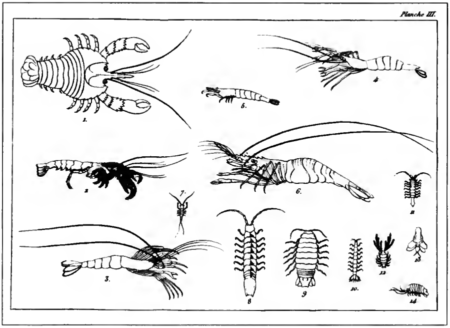
Risso believed that his second species was new, and he named it *Caligus imbricatus* for the winglike scales that concealed the body. This yellow-green copepod was found on a "feroce" shark. Risso's drawing was not particularly good; he was capable of better. But the striking nature of this copepod leaves no doubt that it is not a *Caligus* species.

---

[1] According to Monod and Hureau (1977), Risso apparently sent Bosc a manuscript or a proof copy in 1812; this was favorably reviewed, except for some revealed weaknesses in the illustrations, for the Academy of Sciences.

Copepod species have lain unrecorded since the world began, yet a jesting fate often has seen a single species described independently at the same time. Such was the case with Risso's *Caligus imbricatus.* In the same year, 1816, Leach briefly described a new genus and species *Anthosoma smithi.* Whether Risso's species was first never became an issue—recall that Desmarest was pitching for an 1813 priority date. Risso sent his specimen to Latreille, who in turn showed it to Leach. Leach (1819) had an early second chance at this and declared that Risso's species was the same as *Anthosoma smithi.* Risso also had a second opportunity to set the species right, in 1826, but he unaccountably created another new genus for it, *Otrophesia,* and cited Leach as the authority for the then *O. imbricaria* (see Baird 1850). This was a minor tussle in the long and distinguished history we are reviewing, but it suggests how simple matters are made complex. The jesting fate, as usual, had the last laugh, for both Leach's and Risso's species, whoever was first, fell to that described by Abildgaard in 1794 as *Caligus crassus* (see Wilson 1922). However, Leach's genus survives, and the species is *Anthosoma crassum* (Abildgaard, 1794). This is a striking species, not easily confused as to genus, but its family has changed considerably over the years. It has recently been returned to the Dichelesthiidae (see Kabata 1979).

Illustration of Risso's "Caligus imbricatus" *(Pl. 3, fig. 13). From Risso (1816).*



In a supplement at the end of the long descriptive section, Risso (1816) added a new species of argulid, *Binoculus bicornutus,* using Geoffroy's old genus name. Wilson (1902) believed that the species was identical to that described by Risso in 1826 as *Agenor purpureus,* a new genus and species. Wilson retained the species as *Argulus purpureus* (Risso, 1826), but it seems to me that it should be *Argulus bicornutus* (Risso, 1816). In any case, it is not now a "proper" copepod.

Among the crustaceans of Nice, Risso described seventy-five that he believed were "absolutely new," although he acknowledged that there were many more undescribed species in the region:

> Although the exact description of the species has been the principal object, which I have proposed for my work, I believe I have not neglected the study of habits and of the habitats appropriate to these species; I have indicated for each the depth which they usually occupy in the sea, [and] the nature of the regions which they frequent the most willingly; finally, I have made known, besides the differences of conformation which are noted between males and females, the period of egg-laying of these latter, and as much as I have been able, the approximate number of eggs deposited. . . .
>
> My view has been to quickly explain the characterizations for each species; I will consider myself fortunate, if the true naturalists, those for whom the progress of science is dearer than the special views that direct so many others, appreciate my efforts, and if they are able to find in my work some new facts, or, at least, if they recognize that I was able to approach the object that I had proposed, to add some pages to the grand book of nature. (Risso 1816)

Risso often referred to specimens in the Museum at Paris, and it is likely that he himself had examined these. In 1813 he was in Paris, where he encountered "le cher Lesueur," whom he had met in Nice. Lesueur introduced Risso to Latreille, Lacépède, Duméril, and others (Monod and Hureau 1977). Risso named several species after contemporary naturalists, sometimes referred to as more than mere colleagues:

> The prettiest species [of stomatopod] that I know, and which I dedicate to my friend Desmarest, learned naturalist of Paris, is as widely distributed in our sea as [*Squilla manta* J. C. Fabricius]. . . . Finally, that [isopod *Spheroma*] which I dedicate to my friend *Lesueur,* lives in the rolling pebbles of the Gulf of Nice. (Risso 1816)

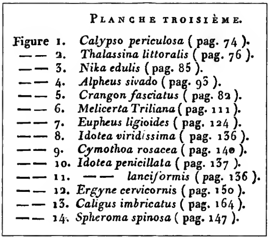
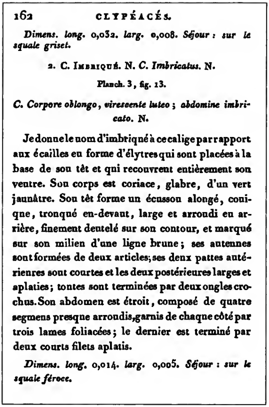


PLANCHE TROISIÈME.

Figure 1. *Calypso periculosa* (pag. 74).
—— 2. *Thalassina littoralis* (pag. 76).
—— 3. *Nika edulis* (pag. 85).
—— 4. *Alpheus sivado* (pag. 93).
—— 5. *Crangon fasciatus* (pag. 82).
—— 6. *Melicerta Triliana* (pag. 111).
—— 7. *Eupheus ligioides* (pag. 124).
—— 8. *Idotea viridissima* (pag. 136).
—— 9. *Cymothoa rosacea* (pag. 140).
—— 10. *Idotea penicillata* (pag. 137).
—— 11. —— *lanciformis* (pag. 136).
—— 12. *Ergyne cervicornis* (pag. 150).
—— 13. *Caligus imbricatus* (pag. 164).
—— 14. *Spheroma spinosa* (pag. 147).

(left) *Explanation of Plate 3. From Risso (1816).*



162 CLYPÉACÉS.

Dimens. long. 0,032. *larg.* 0,008. *Séjour : sur le squale griset.*

2. C. IMBRIQUÉ. N. *C. Imbricatus.* N.

Planch. 3, fig. 13.

C. Corpore oblongo, virescente luteo ; abdomine imbricato. N.

Je donne le nom d'imbriqué à ce calige par rapport aux écailles en forme d'élytres qui sont placées à la base de son têt et qui recouvrent entièrement son ventre. Son corps est coriace, glabre, d'un vert jaunâtre. Son têt forme un écusson alongé, conique, tronqué en-devant, large et arrondi en arrière, finement dentelé sur son contour, et marqué sur son milien d'une ligne brune ; ses antennes sont formées de deux articles; ses deux pattes antérieures sont courtes et les deux postérieures larges et aplaties ; toutes sont terminées par deux ongles crochus. Son abdomen est étroit, composé de quatre segmens presque arrondis, garnis de chaque côté par trois lames foliacées ; le dernier est terminé par deux courts filets aplatis.

Dimens. long. 0,014. *larg.* 0,005. *Séjour : sur le squale féroce.*

(right) *Text of Risso's* "Caligus imbricatus." *From Risso (1816).*

Risso returned to Paris in 1838, where he was again enlightened and entertained by a host of naturalists. Risso corresponded with nearly every important contemporary European naturalist (Monod and Hureau 1977). These included many who are mentioned in these pages: Audouin, de Blainville, A. Brongniart, Bory de St. Vincent, de Candolle, Cuvier, Desmarest, Duméril, Geoffroy St. Hilaire, Humboldt, Latreille, Lesueur, Johannes Müller, Oken, Otto, Péron, Roux, Say, Schrank, and Schweigger. Several of his correspondents took advantage of the mild Nice winters, and no doubt also of Risso's hospitality.

Risso's second publication with copepods was the already mentioned 1826 series on the "Natural History of the Principal Productions of Southern Europe," a five-volume tour de force covering the area around Nice and the maritime Alps. The first volume covered meteorological conditions, based on twenty years of records. The second volume dealt with plants, perhaps Risso's strongest biological specialty. Forty-nine species of mammals, including dolphins, were addressed in the third volume, while mollusks were dealt with in the fourth. The fifth volume described crustaceans, arachnids, insects, worms, radiates, polyps, and sponges.

Among the copepods newly described was another named for Risso's friend but placed in a Leach genus: *Cecrops desmaresti.* Wilson (1923) pointed out that the species cannot be in this genus because of the structure of the first and third legs. Risso's species remains unknown (Kabata 1979).

The 1826 volume also designated the new genus and species *Nemesis lamna,* placed now by most workers in the Eudactylinidae. There are now seven valid species in this Risso genus (Kabata 1979). Risso also described two new species, *Chondracanthus lophius* and *Pandarus rouxi.* Finally, he reported *Caligus minimus* Otto, 1821 (see Brian 1906).

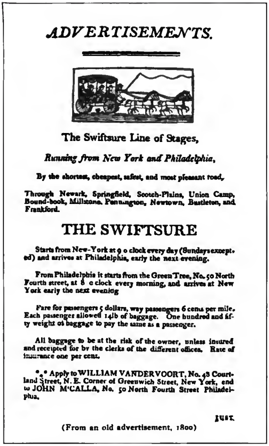
Agassiz (1854) listed sixteen Risso papers on fishes, snakes, insects, and geology. The 1826 volume covering insects includes a table prepared with Leach's assistance (Hagen 1863). Risso published four substantial botanical works, including famous monographs on citrus trees. He was responsible for naturalizing the olive and citrus trees now so characteristic of the north Mediterranean landscape (Pilleri and Arvy 1981).

Risso belonged to many scientific societies, listed on the title pages of his publications. These included the Royal Academy of Science at Marseille, the Academy and Society of Natural History in Geneva, the Geological Society of London, and the Academy of Natural Sciences of Philadelphia.

George Samouelle

?–? 1846

George Samouelle was an unfortunate man who seems to have been placed in a position above



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JUST.

(From an old advertisement, 1800)

Description of a scheduled two-day trip between Philadelphia and New York, ca. 1800. From Kelly (1914).

his capacity. With copepods, he is but a footnote. Samouelle had been a clerk to a bookseller when he came to the British Museum to work on insects, at the same time Leach was recruited. It is fairly clear that Leach helped him over and above the call of duty, which suggests that Samouelle must have had some good qualities. Leach gave his insect notes to Samouelle; Samouelle used them for his popular *Entomologist's Useful Companion*, in 1819, which was dedicated to Leach (Gunther 1980). This book incorporated a nomenclature of British "insects" alphabetically arranged. The list included *Cyclops geoffroyi*, undoubtedly a species that Leach had in manuscript. Baird (1850) believed that it represented that favorite catchall species *Cyclops quadricornis*.

In 1826, Samouelle brought out a seventy-page *General Directions for Collecting and Preserving Exotic Insects and Crustacea: Designed for the Use of Residents in Foreign Countries, Travelers, and Gentlemen Going Abroad.*[2]

When Leach left the museum, Samouelle took over his position. A long twenty years later, in 1840, Samouelle was sadly dismissed for persistent dereliction of duty. Samouelle had no real scientific aptitude; in contrast to Leach, he seemed incapable of independent work (Gunther 1975, 1980). Samouelle was an associate of the Linnean Society from 1818; he published a two-volume work, *The Entomological Cabinet*, in 1834. Thirty-four years later, Bate and Westwood (1868) were reminding readers that "Dr. Leach [was] the chief authority for Samouelle's work." Gunther's (1980) excellent review of the early days of the British Museum includes a Samouelle portrait.

To compensate for the increasing collections, and perhaps also for the loss of Samouelle, the museum brought in William Baird (1803–1872). Baird, whom I hold in high regard, has already been mentioned several times in this review. One might rightfully be surprised to learn that Baird was hired to work on mollusks, and another man (of no copepod significance) replaced Samouelle on insects (Gunther 1975). I would not want to say that Samouelle's removal was responsible for Baird's appointment, but the timing, always critical, is apparent.

Thomas Say

27 June 1787–10 October 1834

Thomas Say was the first American to publish a scientific report that included copepods. Say's work established new ground over such extensive fields that he has been called the "Father of American Entomology," the "Father of American Conchology," and even the "Father of American Zoology." They are titles well deserved. Invertebrates of the New World had been described occasionally by others, but Say was the first to compile significant and comprehensive reports.

Say's father was a prominent Philadelphia physician. Thomas Say availed himself only of a primary education, even though he could have attended any school of his choice. What he liked to do was collect butterflies and beetles. In his youth he worked in his father's pharmacy, and that profession seemed to beckon as his own. However, when Say established an independent pharmacy, he failed as a businessman. At the age of twenty-five, he decided to devote himself entirely to natural history studies (Weiss and Ziegler 1931).

From youth, Say was a "pupil" in the botanical garden of William Bartram (1739–1823), whose *Travels* from 1791 is a natural history classic. Bartram was Say's great-uncle; under Bartram's guidance, and that of Bartram's ornithologist neighbor, Alexander Wilson (1766–1813), Say gained an informal but priceless education (Goode 1901b). The twenty-one-year-old Say almost certainly met the twenty-two-year-old Thomas Nuttall (1786–1859) in Bartram's garden in 1808. They became intimate, lifelong friends. Nuttall, who was born in England and also died there, was American in every other way and one of America's supreme botanists. Nuttall was the first professional scientist to cross, ocean to ocean, what is now the United States, in 1834–1836 (Graustein 1967, Gilbert 1979).

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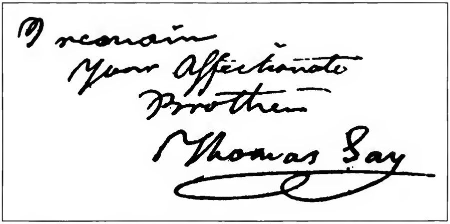
[2] Listed in the Cambridge University Library catalog.

In the young United States, Philadelphia was one of few centers of learning. In January 1812, a social group of science-oriented men decided, as an afterthought, to call themselves an "Academy." This matured into the Academy of Natural Sciences of Philadelphia, incorporated in 1817. Say joined in April 1812, and together with George Ord (1781–1866) and Lesueur was a "Curator" of the collections. Ord became a well-known expert on mammals and ultimately Say's and Lesueur's biographer. The strange odyssey of the French naturalist Lesueur will be revealed when we look at his 1824 contribution (albeit small) to copepodology. Like J. C. Fabricius, who also made relatively small contributions to copepod studies, Lesueur is a personal thread of surprising length and strength.

Another individual critical to Say's story is William Maclure (1763–1840), who has been called the "Father of American Geology." This epithet, coming as it does on the heels of Say's endorsements, serves to emphasize the scientific aptitude in that circle. Maclure was born in Scotland and made a fortune trading with the new United States; he moved there and became a citizen around 1796. He was a founder and patron of the Academy of Natural Sciences and served as its president from 1817 until his death twenty-two years later. His portrait shows a man understandably proud of his share in the first four volumes of the academy's *Journal*. Maclure was also a founder (in 1819), and first president, of the American Geological Society (Goode 1901a). I have a distinct impression of Maclure traversing the fields with geologist's hammer in one hand and wallet in the other. He was ever generous in support of scientists, like Lesueur and Say; unfortunately, Maclure's enthusiasm for social causes, and the loyalty he engendered, eventually led his foremost followers away from science. In 1828, Maclure moved to Mexico for his health, retaining strong ties with Philadelphia until his death.

Maclure sponsored an academy expedition to the sea islands of Georgia and to eastern Florida in 1817–1818. He was accompanied by Say, Ord, and Titian Ramsay Peale (1799–1885), budding artist, naturalist, and academy curator.[3] The Maclure expedition gave the young participants valuable experi-

Thomas Say (1787–1834). From Weiss and Ziegler (1931).



I remain
Your Affectionate
Brother
Thomas Say

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[3] Two decades later, Peale had years to tell the geologist James Dwight Dana (1813–1895) of his travels with and thoughts about Say. Say's account of crustaceans was incidental, as was Dana's (as well as Darwin's), but as we will see in Volume 2, everything is relative, and incidental can be monumental.

William Maclure (1763–1840). From Goode (1901a).

ence and increased the academy's collections. At that time, Florida was still owned by Spain; this natural history excursion ranks among the earliest in that area. The enterprise was terminated when the hostility of the Seminoles became unbearable (Goode 1901b, Poesch 1961).

Say's next field experience came on the western expeditions of Major Stephen Harriman Long (1784–1864). Say was the zoologist and Peale was the assistant naturalist on Long's 1819–1820 exploration of the Colorado Rockies (Poesch 1961). Say had the same duties on an expedition to Ontario and Manitoba in 1823 (Goode 1901b).

The first scientific description of the grizzly bear, *Ursus horribilis*, was given by Say in 1826, with a name suggested by Ord. Say's expedition journals held wonderful accounts of many yet-unspoiled Indian cultures (Poesch 1961).

Although Say was fairly well-to-do because of family wealth, he chose to live frugally, sleeping in the academy's halls under the skeleton of a horse. He ate, slept, and breathed natural history (Goode 1901b).

DeKay (1826) summarized the state of natural history studies in America during this period:

> Previous to the epoch of the late war with England, although a few works of merit had appeared at distant intervals, yet the Natural Sciences were but partially cultivated. The few individuals who had turned their attention to such pursuits were too widely scattered over this extensive country, to allow of that familiar interchange of opinions which necessarily elicits further inquiries and discoveries. At a still earlier period we may refer to our colonial situation, the embarrassments arising from our exposed and peculiar position, and the example of the mother country, as among the most prominent causes which impeded the cultivation of Natural History in the United States.
>
> Since, however, the period to which we have alluded, and the general peace which subsequently ensued, a spirit of inquiry has been awakened. The forest, and the mountain, and the morass have been explored. The various forms and products of the animal, vegetable, and mineral kingdoms have been carefully, and, in many instances, successfully investigated. A proper feeling of nationality has been widely diffused among our naturalists; a feeling which has impelled them to study and examine for themselves, instead of blindly using the eyes of foreign naturalists, or bowing implicitly to the decisions of a foreign bar of criticism. This, if restrained within due bounds, if it is not perverted into a narrow and bigotted [*sic*] sentiment, that has not unfrequently been mistaken for national feeling, must be attended with beneficial consequences. To those who feel disposed to undervalue the useful and meritorious labours of foreigners, it may be suggested whether some deference is not due to the judgments of those learned individuals who have spent long and laborious lives, often in the investigation of a single group of phenomena, in the illustration of a single class, order, or genus of natural objects. (DeKay 1826)

The early work of the Philadelphia academicians showed no lack of reference to the newest and best European literature. Say himself corresponded with Leach and others, and he seems to have received publications directly. In turn, Say's work was quickly incorporated into European literature; Say was the first American entomologist to be judged the equal of his European counterparts (Weiss and Ziegler 1931). He described about fifteen hundred new species of insects (Graustein 1967).

There were only two scientific journals, and a few medical journals, in all of America at that time.[4] It was Maclure's idea that the academy publish an outlet for original research. A committee of Maclure, Say, Nuttall, and Ord was given the responsibility of producing a journal. By May 1817, the first number of the first part of the first volume was published in an edition of fifty copies. The academy had all six numbers of Part One printed professionally in Philadelphia, the last being in December 1817. The cost of even this unfortunately low-quantity printing was considered too high, and the second half of the first volume was printed by volunteers—Say and Nuttall—in Maclure's house. Eight unnumbered segments were printed by December 1818. During a short period of bitterness in 1838, Nuttall wrote: "Of all the papers I furnished them I have *never been able* to obtain, in any way, (except by buying their journal) a single copy for distribution. So much for the gratitude of public bodies! and (would be) Scientific Societies" (Nuttall, qtd. in Graustein 1967).

Say's work on crustaceans, including copepods, was published in several installments in the first volume of the academy's *Journal* in 1817 and 1818. The one plate, the original drawing of which is now in the Museum of Natural History in Paris (Bonnemains and Jones 1990), was due to "the friendship of Mr. C. A. Lesueur." Say (1818) reported four copepods in the series' last full installment; none of the copepods were illustrated. As a modern touch, he informed the reader that certain specimens were deposited "in the cabinet of the Academy." Sad to relate, the insects, and presumably the crustaceans, did not last long. Ord recorded in 1835 that "this cabinet has been since entirely destroyed" (Weiss and Ziegler 1931). The more resistant mollusk shells remain, and their worth was early noted:

> Wishing for every possible confirmation that the names I had used were applied to the same shells that Mr. Say applied them to, I visited the cabinet of the Academy of Natural Sciences, at Philadelphia, where authentic specimens of most of the species described by Mr. Say are deposited, and which is, in other respects, a most valuable cabinet to the American naturalist, as it is the most ancient. (Gould 1841)

Thomas Say (1787–1834). From Goode (1901b).

For crustaceans, Say followed the 1817 classification of Latreille, grouping his copepods among two sections within the Order Branchiopoda: Section I. Paecilopa (*Pandarus*, *Caligus*, and *Binoculus*) and Section III. Lophyropa (Cyclops). The first copepod was *Pandarus sinuatus*, a new species from the dogfish shark. This remains a valid species (Kabata 1979). The second copepod, also a new species, was *Binoculus caudatus*, from a mud-shrimp burrow at St. John's River in Florida; this is now *Clausidium caudatum* (Say, 1818) (see Wilson 1921). A third new species described by Say was *Cyclops naviculus* from stagnant freshwater of the southern states. Vervoort believed it to be unidentifiable. That it is a Cyclops species is fairly certain because of its dual egg sacs and relatively short antennae. Say mentioned a fourth copepod, from codfish: *Caligus piscinus* (Linnaeus), now *Caligus curtus* Müller (see Vervoort in Holthuis 1969).

Say (insects, crustaceans, mollusks) shared the first volume of the academy's *Journal* with Lesueur (mollusks, fish, reptiles, actinians), Maclure (geology), Ord (mammals), Isaac Lea (1792–1886) (geology, fossils), Nuttall (plants), and Rafinesque (fish). Without intention, these contributions formed a treasured handbook of previously unexplored

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4. *Transactions of the American Philosophical Society* of Philadelphia from 1771 and the *Transactions of the American Academy of Arts and Sciences* (Boston) from 1780. A *Memoir* series from 1785 was no longer published.

North American natural history, compiled by the early giants of the field (Dall 1888, Goode 1901a).

American natural history was an unworked mine when Say came on its scene; he opened it to others and pointed out the veins. North America's first fossil invertebrate was described by Say in the first volume of Silliman's *American Journal of Science*, in 1818. Say, before others in America, realized the chronological importance of fossilized strata. He published other reports on fossils; these were collected and reprinted in 1896 (Weiss and Ziegler 1931). Say's *American Entomology* was published in 1824–1828 and dedicated to Maclure. Most of the fifty-four plates were drawn by Peale, with nine by Lesueur (Weiss and Ziegler 1931). Its abiding value is attested to by reprintings in 1859, 1869, 1885, and 1891.

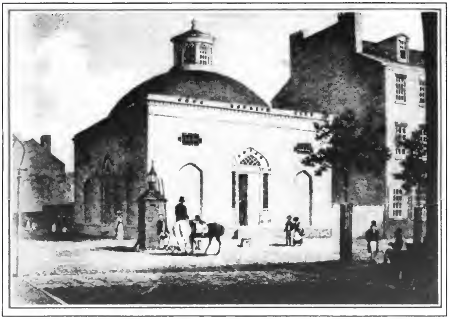
Another man now entered and altered Say's life. This was Robert Owen (1771–1858), a wealthy Welsh socialist. Owen practiced what he preached, and his own English mills were models of reform, abolishing child labor, establishing health- and old-age insurance, and fostering educational and recreational opportunities. Owen founded a cooperative community in England. This may have succeeded in the Middle Ages when neighbors tended to help one another, but in the Industrial Age it was a doomed experiment. Owen then brought his ideas to America.

In the America of those days, anything west of the Appalachians was a promised land for both homesteader and naturalist. On the banks of the Wabash River in Indiana, Owen founded a new utopian city, New Harmony. He convinced Maclure of the merits of his project, and Maclure convinced others.

As colonizers to this aspiring Garden of Eden, Owen and Maclure enticed a "boatload of knowledge" from Philadelphia. Thomas Say, late of the Academy of Natural Sciences of Philadelphia, was among those disembarking at New Harmony in January 1826 "where the sum of human happiness, it was believed, would be exalted; and where science and letters, it was confidently affirmed, would soon arise, like the orient sun, to enlighten our benighted western world" (Ord, qtd. in Weiss and Ziegler 1931). Owen's son, Robert Dale Owen (1801–1877) was with them.[5] Also with them were two immigrant scientists, Gerard Troost (1776–1850) from Holland and Lesueur. Troost, academy president for five years, had been a student of the mineralogist Haüy in Paris (Goode 1901b, Peattie 1938).

The exodus of learned members from the Academy of Natural Sciences of Philadelphia was felt for fifty years; this was probably the first brain-drain in America. After that, the U.S. center of natural history shifted to New Haven and Cambridge. Strangely, New Harmony became something of a satellite station for the parent academy and, therefore, an attraction to visiting naturalists from Europe. For the rest of his short life, Thomas Say was the highest authority on North American mollusks, insects, and crustaceans. Handsome and personable, and a dedicated teacher, he was admired by all. But the bulk of his original work was now behind him.

At New Harmony, Say was responsible to the commune for "Literature, Science, and Education." There he finished as much of his *American Conchology* as he was to do, and it was printed at New Harmony's own press in 1830–1832. Two of its colored plates were drawn by Lesueur, and the other sixty-six by Lucy Say, Thomas's wife since 1827. The best part of that work was the plates; the text was on poor quality paper and poorly printed. However, the facts are time-honored, and the monograph was reprinted in 1858 (Weiss and Ziegler 1931).



The Academy of Natural Sciences of Philadelphia in the time of Thomas Say. From Herrick (1938).

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[5] Robert Dale Owen taught school and edited the newspaper at New Harmony. He was later a U.S. Congressman and Ambassador to Italy, and he had a prominent role in the founding of the Smithsonian Institution.

Writing to a friend two years after Say's death, Lesueur recalled that

> Mr. Say had languished for a long time with a liver ailment. After having passed many nights on his bed, his malady grew worse and rendered all of our efforts useless and in vain.
>
> His wife returned to Philadelphia and afterward, with her, all of Mr. Say's collections and all of his natural history books, along with those that Mr. Maclure permitted her to take. The librarian at the Natural History Society of Philadelphia will soon have nearly all of Mr. Maclure's library, these last being a gift to this Society. Thus, my dear friend, we no longer have anything here to offer a traveler.
>
> You ask what do we do here. I complain about rheumatism. To free myself, I take my shotgun and I go into the woods. Please remember me to your amiable children and your wife. (MS letter, Lesueur to Desmarest, 21 February 1836, Le Havre Museum)

Although Say missed being an original member of the academy by four months, "it was subsequently determined, as a mark of respect, that his name should be enrolled among those of the founders.... With all those who had the happiness of his acquaintance, the name of Thomas Say was synonymous with honor, and his word the expression of truth" (Ord, qtd. in Weiss and Ziegler 1931). Say was a corresponding member of the Société Philomatique (Paris), one of fifty foreign members of the Linnean Society (London), and one of twenty-five foreign members of the Zoological Society (London). Say's library and collections were given to the academy by his widow, who was without dissension elected a member (Graustein 1967).

Say left more than fifty publications, mostly in the *Journal of the Academy of Natural Sciences of Philadelphia.* Lesueur named a new species of ray for his friend Say, as well as for Maclure. One of America's best-loved birds, the eastern phoebe Sayornis phoebe, was given its genus name at the British Museum by George Robert Gray (1808–1872), the brother of Leach's protégé J. E. Gray. The western species, *Sayornis saya*, is known as Say's phoebe. The original specimen was collected by Peale on Long's expedition to Colorado. The species name is from the ornithologist Charles Lucien Jules Laurent Bonaparte (1803–1857), nephew of Napoleon and refugee-resident of Philadelphia.

In 1846, a monument to Say was placed on Maclure's estate at New Harmony (Dall 1888). On this we read perhaps a little about ourselves:

Votary of Nature, even from a child,
He sought her presence in the trackless wild.
To him the shell, the insect, and the flower
Were bright and cherished emblems of her power;
In her he saw a spirit all divine,
And worshipped like a pilgrim at her shrine.

Just as social experiments on all scales have failed, so the ideal colony at New Harmony fell to pieces after only two years:

> The *New Harmony Gazette* outdid itself in rapturous reporting.... True, the editors were men and women of education, high intelligence, higher moral ambition; they never printed a scandalous story; they stooped to no yellow journalism or cheap effects of any sort; the contents of their sheet were meaty with ideas and unsullied with trivia and vulgarity. But they were writing sheer propaganda; they ignored all adverse weather signs; they refused to print opinions contrary to those which would advance their millennium. No mention of uncertainty, dissension, doubt, misery, unfairness, or maladjustment sullies their blue skies except for occasional references to the overcoming of past obstacles. Every week the clouds completely cleared up all over again, and the signals of fair weather were run up once more at the editorial masthead, as they had been the week before....
>
> Constitution after constitution was substituted at New Harmony, but the *Gazette* makes them seem merely like improvements amended upon the original document, instead of the desperate flounderings of a drowning idea. For the millennium was showing alarming signs of departure. The moochers howled because, after all, they had to work. The industrious complained that as fast as the fruits of their toil accumulated, they were borne off by the parasitic. In a town which was supposed to have abolished money, people were ready to sell their souls for the feel of hard cash. (Peattie 1943)

New Harmony's sole but substantial legacy was the first modern educational system in America. There were also strong antislavery and pro-women's rights sentiments. The glory days of New Harmony passed quickly, but because of the classic geological survey of Indiana by another of Robert Owen's sons, a significant part of the U.S. Geological

Survey clustered there. The town remains a Mecca of sorts to those interested in the early experiment in cooperative living, where one might still hear the song of *Sayornis phoebe*.

* * *

As the nineteenth century began, the view of copepods was rather tentative, usually through Lamarck's classification as shown by Bosc. For the free-living copepods and their close relatives, Müller's Entomostraca was well entrenched, first within insects, then quickly within the new Class Crustacea. Likewise, Müller's copepod species were widely recognized—certainly too much so. Bosc and others, however, realized rightly that Müller's *Amymone* and *Nauplius* were but immature *Cyclops* species, and the two names disappeared as genera. Latreille's 1810 and 1817 crustacean classifications were accepted by the principal workers, changing as Latreille modified them.

Copepodologists will ever honor their colleagues J. F. Hermann and Delaroche for *Dichelesthium* and *Chondracanthus*. Leach will always be remembered for his colorful names *Anthosoma*, *Calanus*, *Cecrops*, and *Pandarus*. Risso did not establish a lasting new genus before 1820, but we recorded his quaintly named *Nemesis* from 1826 (see Kabata 1988). It was not until 1832 that the highly modified parasitic copepods would finally be given crustacean status, even though Suriray (1819) had revealed earlier that this would be appropriate. We will consider Suriray's observations within the advances of the third decade.

Most classifications held the "lernaeid" copepods to be mollusks or worms. The first to make arrangements within this grouping was Oken, who also implied for them a closer relationship to the accepted crustaceans. Surviving from Oken's work was the exchange of *Pennella* for the copepod fraction of Linnaeus's *Pennatula*, and a new genus *Clavella* for an old nonlernaeid *Lernaea* species.

Several copepod species were described (and redescribed) between 1800 and 1820. Both marine and freshwater coverage was widening, with reports from France, Germany, Italy, Switzerland, England, the Gulf of Guinea, Brazil, Kamchatka, and the United States. Here we found the first records from America by an American, Say, infused with Old World experience through the cosmopolitan copepodologist Lesueur. The two decades were capped by Jurine's (1820) great posthumous monograph on entomostracans, to be examined next.

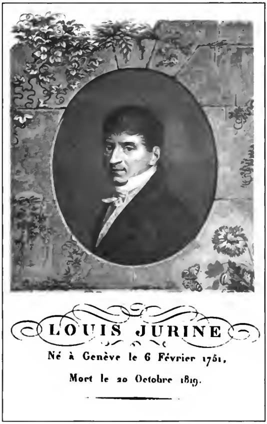
12

MONUMENT TO A MUCH-LOVED DAUGHTER

> Naturalists who are following the progress of our knowledge of the entomostracans will perhaps be surprised to note the appearance of a new dissertation upon a subject which they might believe exhausted, where nothing more of interest could be presented. I hope nevertheless to justify the contrary opinion, either to give the solution of some physiological problems, or to add some discoveries to those which have been made up to the present.
>
> —JURINE, *Histoire des Monocles*

> It is apparent that Jurine . . . must have been a rather remarkable person. . . . It is perfectly normal, that a man like Jurine should have been forgotten in his own country!
>
> —JEAN G. BAER, *Letter to Author,* 13 AUGUST 1974

JURINE'S BEAUTIFUL MONOGRAPH (1820) on the copepods of the Geneva region is at once the culmination of the post-Linnaean period and the commencement of a premodern period that extended toward the end of the nineteenth century. Jurine's work on copepods began about 1790 and was essentially completed about 1804; it is a credit to him and his family that he had the spirit to conceive and to carry through such a noble undertaking, without which Jurine would have been the barest footnote and our science would have been deprived of one of its most charming and original efforts. Unfortunately, like Müller, Jurine died shortly before his great copepod contribution was published. This "Natural History of the Entomostraca of Geneva" was, and remains, one of the supreme highwater marks of copepodology. The late Dr. Jean Baer, quoted above, would be especially pleased to learn of the recent surge in interest in Louis Jurine (Sigrist 1995).



Louis Jurine (1751–1819). From Borgeaud (1909).

Louis Jurine

6 February 1751–20 October 1819

Louis Jurine's last wish was that he not be the object of a public eulogy, and this seems to have been respected in the extreme, judging from the scanty biographical information on Jurine. There is some confusion even about his birth date. I found this recorded as 1749 as well as the more frequent 6 February 1751, which is probably correct (Folman 1948). Jurine was born in Geneva to a family originally from Lyon (Revilliod 1942, Sigrist 1995); for about a third of Jurine's life, from the time of the French Revolution until the fall of Napoleon, Geneva was a part of France. Jurine's father encouraged Louis in an early interest in both medicine and natural history (Jourdan 1822c, Bayle and Thillaye 1855). Young Jurine obtained a Master of Surgery degree in Geneva in 1773 while being guided in natural history studies by Charles Bonnet, corresponding student of Réaumur and lifelong friend of O. F. Müller. Bonnet's major achievements had been with insects (he had discovered parthenogenesis) and philosophy (his evolutionary thoughts had foreshadowed Lamarck's). Jurine was also directly influenced by Horace Bénédict de Saussure (1740–1799), Professor of Philosophy at Geneva, known for his contributions to geology and physics.

Jurine practiced for a short while in Geneva as a master of surgery, after which his father sent him to medical school in Paris in 1775 (Borgeaud 1909). This was then probably the best school of Europe, and Jurine was thoroughly grounded in theoretical and practical medical knowledge. He obtained his M.D. degree and earned such a reputation as a young scholar/physician that it was understood that Jurine would eventually become administrator of Paris hospitals and Professor of Hygiene at the Medical School of Paris. For brilliant studies on angina pectoris and other thoracic diseases, Jurine was awarded prizes from the Medical Society of Paris (Anon. 1820a, Pictet 1820, Jourdan 1822c, Borgeaud 1909, Revilliod 1942). Jurine was elected a nonresident associate of the anatomy and zoology section of the National Institute of France in 1799 (Folman 1948). He was assuredly on the road to fame and fortune; only his passion for natural history stood in the way.

Jurine, now a medical victor, returned to Geneva to be near his family in the late 1770s (Jourdan 1822c). After this, Jurine's life took two roads. The first was his application to the medical arts. His broad background, novel and skillful operations, and a popular anatomy course enhanced his reputation. He consulted in France, Germany, Italy, and England (Anon. 1820b). Jurine was appointed Professor of Anatomy and Surgery at the University of Geneva in 1802 (Revilliod 1942). He was also the chief surgeon at the Geneva General Hospital (Jurine 1820).

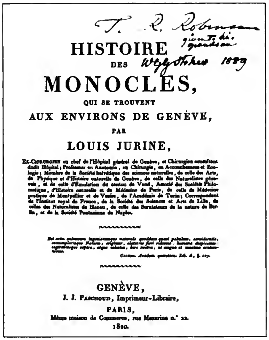
In 1807, Napoleon established a prize of twelve thousand francs for medical research and treatment of laryngeal inflammation, or croup, of which a nephew had just died. A commission of important French physicians reviewed eighty-three memoirs submitted in competition. Two essays were judged to be superior; those from Jurine and one other, and the prize was shared equally in 1812 (Anon. 1820a, Folman 1948). By this time, Jurine was a consulting surgeon to the Geneva hospital. His essay on croup was still considered the best on the subject as late as 1855 (Bayle and Thillaye 1855).

Jurine never dropped his concurrent interest in natural history, which was not reserved for leisure hours during a lifetime as a medical practitioner. For Jurine, natural history was the favored pursuit, and he incorporated this into a busy schedule with medicine. Little by little, the medical practice gave way, and finally Jurine the surgeon only consulted, while Jurine the naturalist became ever more celebrated and justly admired (Anon. 1820a). Jurine was a founder of the Geneva Society of Natural History in 1791 (which became the Geneva Society of Physics and Natural History in 1798). In 1809, Jurine was named Professor of Zoology at Geneva. In 1815, he was among the founders of the Swiss Society of Natural Sciences (Borgeaud 1909, Sigrist 1995).

Agassiz (1853) listed eleven Louis Jurine papers on natural history subjects, including André Jurine's memoir on *Argulus* from 1806 (already mentioned). A genuine Louis Jurine paper, from 1807, was a new and strong classification of Hymenoptera and Diptera (insects), using wing venation (Tuxen 1973). This monograph was beautifully illustrated with fourteen colored plates of five hundred figures drawn by Jurine's daughter, Christine. Christine Jurine (1776–1812) was the older of two Jurine daughters (Sigrist 1995).

> Jurine's principal observations and discoveries were recorded in a number of memoirs addressed to various scientific societies to which he belonged, among which we are pleased to include the Society of Physics and Natural History of Geneva, and which, for the naturalists of our town, grew into the great Société Helvétique. (Anon. 1820a)

Jurine published one short paper each on the teeth and eyes of some fishes, on bats, and on the snakes



T. R. Robinson
given to his grandson
WGG Stokes 1889

HISTOIRE
DES
MONOCLES,
QUI SE TROUVENT
AUX ENVIRONS DE GENÈVE,
PAR
LOUIS JURINE,

Ex-Chirurgien en chef de l'Hôpital général de Genève, et Chirurgien consultant dudit Hôpital; Professeur en Anatomie, en Chirurgie, en Accouchemens et Zoologie; Membre de la Société helvétique des sciences naturelles, de celle des Arts, de Physique et d'Histoire naturelle de Genève, de celle des Naturalistes genevois, et de celle d'Émulation du canton de Vaud, Associé des Sociétés Philomatique, d'Histoire naturelle et de Médecine de Paris, de celle de Médecine pratique de Montpellier et de Venise, de l'Académie de Turin; Correspondant de l'Institut royal de France, de la Société des Sciences et Arts de Lille, de celles des Naturalistes de Hanau, de celle des Scrutateurs de la nature de Berlin, et de la Société Pontanienne de Naples.

GENÈVE,
J. J. Paschoud, Imprimeur-Libraire,
PARIS,
Même maison de Commerce, rue Mazarine n.° 22.
1820.

Title page of Jurine's posthumous Histoire des Monocles *(1820).*

of Geneva. A larger work, on the fishes of Lake Geneva, was published posthumously in 1825.

Jurine the amateur naturalist gave considerable and prolonged attention to the Entomostraca, and it is for this attention that he is honored now. Jurine was in fact reviewing the proofs of his splendid monograph on the entomostracans of the Geneva region when he was stricken with a severe heart attack, ironically a disease that he had made his medical specialty (Borgeaud 1909). To the dismay of his family and many friends, he pronounced his ailment to be fatal, in spite of possible treatment. Nearly three days later, 20 October 1819, Jurine died at Chougny, commune de Vandoeuvres, near Geneva (Folman 1948). He was remembered as the most clever of Geneva's many clever physicians (Bayle and Thillaye 1855) and one of the most illustrious scholars of Europe (Anon. 1820b):

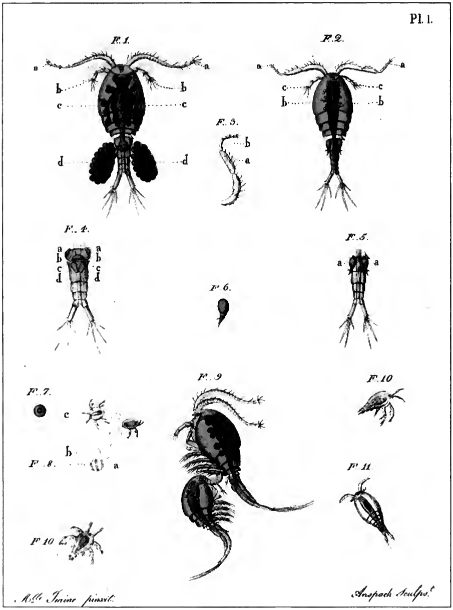
> He left, in his magnificent cabinet, objects of curiosity and admiration for the instruction of all researchers, a monument to his knowledge, to his perseverance, to his spirit of order, and to a rare talent in the choice, preparation, and arrangement of the innumerable objects of the collection, unique for its kind, and which, we trust, will never leave Geneva. (Anon. 1819)

We can easily forgive Jurine (1820) for taking "a step backward" (Schmeil 1892) in that he ascribed most of his Entomostraca to one genus, *Monoculus*, the old shadow of Linnaeus. In total, however, there were many steps forward, especially in behavior and ecology, subjects covered in those days under "natural history." No one could deny Jurine his credit, not even the great detailler Schmeil, who acknowledged Jurine's work as "painstaking" and "conscientious."

I was much moved by Jurine's text and believe that he is far the better narrator of his own thoughts on our subject:

> It has been many years since I began the study of the monocles [entomostracans] which are found in the vicinity of Geneva, and since that moment there have been few days that I have not been occupied with a new pleasure. At first sight, such an interest might appear as a surprise, but if one considers the number and the smallness of these animals, one is aware that it would take much time to acquire fairly exact notions of their organization and their habits. It is not just that they are microscopic and one cannot understand them with just a simple view. The difficulty is much greater if one must study the animals always in motion, with their surprising expressions of functions, and in knowing the organs with their various relationships.
>
> To minimize the dryness of anatomical descriptions, I have restricted them as much as possible. I ask, in this regard, an indulgence; I ask that one should consider these as geographic charts that accompany the text of a voyage; even if they are not pleasing to the general readers, they are indispensable to those who would follow the same path.
>
> When I undertook the study of the [entomostracans], I did not suspect the total extent of the task that I imposed upon myself; I did not at all know then which of the authors had written on the subject; I was determined not to read each and every study of these animals, in the fear that they would make it more difficult to guard against prejudices, that could by their nature make an impression upon the mind in a story where the facts themselves are reported. If I had acted differently, I would have without doubt saved much time, but also I would have committed errors that I believe have been avoided.
>
> It would have been impossible for me to have achieved the results of my work in a satisfactory manner, if my

> eldest daughter, dedicating her paintbrush to me, had not made the sacrifice to me of all the time necessary to follow my observations and my experiments, to examine and reexamine with me the same objects which she represented with elegance and truthfulness.
>
> Since praise for these drawings would be improper out of the mouth of a father, I leave it to the enthusiasts to be the judges, and I confine myself to say that all these [entomostracans] have been illustrated to one and the same scale, which will facilitate the comparison of their relative sizes. (Jurine 1820)



Monoculus quadricornis rubens. ***From Jurine (1820).***

Although few if any copepod figures predating Jurine's drawings show so many details so correctly, the figures are in this regard not without flaws. For decades afterward, none portrayed the free-living copepods as well, and few from any time have done so as attractively as the seven copepod plates of Mlle Jurine.

Jurine included a table of scales relating each habitus drawing to the actual size. Usually he reported lengths in lines, but in this table the fairy shrimp was measured in meters ("0.042 metres"), with the figure of the female given as "66 lignes," with an "augmentation" of 3.5448 times. In this case, then, each Jurine line would represent 2.26 mm, compared to the English line of 2.12 mm.[1]

Jurine was thorough in his treatment of the literature up to about 1810. He acknowledged that O. F. Müller (1785), with his *Entomostraca,* had done the most to expand knowledge in this field: "Without fearing to set back science, I have reinstated for all these animals the old generic name 'Monocles,' which refers to the most obvious feature of their organization" (Jurine 1820). Jurine believed that the very obvious two eyes of fairy shrimp (branchiopods) were analogous to one, and that more important features placed these with the other "Monocles."

Jurine was ambiguous in regard to the placing of Monocles within the Crustacea. He implied that this group was comparable to Müller's Entomostraca but did not label the Monocles as a subclass, section, order, or anything else. He said that the Monocles were equivalent to Lamarck's Sessiliocles, Section 1 under the Order Crustaces, from 1801.

Jurine also reviewed Latreille's system from 1802–1805, wherein the Entomostraca were a subclass of the Crustacea. (Only here did Jurine directly equate "our Monocles" to "Entomostraca.") This in turn held two sections, with Jurine's Monocles included in Order 4 (Ostracodes), Order 5 (Pseudopodes), and Order 6 (Cephalotes) across both sections. All of Jurine's copepods would have been in the Pseudopodes, a fact that he acknowledged by synonymy to his own system. Jurine "does not see the utility of all these new names, only confusion; they do not add to the knowledge of these animals" (Jurine 1820). Of course, he did not at all deal with the profusion of parasitic species.

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[1] This agrees with Elting's (1988) statement that the French foot from Napoleon's time was nine lines longer than the English foot.

Finally, Jurine reviewed Latreille's system from 1817, with its Order Branchiopodes, which Latreille himself alternately called "Monocles." Of the three branchiopod sections given by Latreille, two were for free-living forms, and these would include all species described by Jurine. However, Jurine found fault with every system that he knew about, and rather than modifying any to suit his understanding, he essentially began anew with Linnaeus. All of Jurine's species were assigned to the genus *Monoculus* except for the fairy shrimp, which he called "Chirocephales" (equivalent to a genus *Chirocephalus*). By setting these adrift from the genus *Monoculus,* Jurine only emphasized the ambivalence he must have been experiencing by the time he sent the monograph to the publishers.

Whatever level Monocles may have held under the crustaceans, Jurine's simple classification split the Monocles into two natural divisions: those with a univalve shell and those with a bivalve shell. All of the Geneva copepods were included under the first division (Monocles univalve), within an unnamed first family. In brief, these species were characterized by:

1. Elongate-oval form.
2. Forked tail, straight, uncovered.
3. Two long and simple antennae.
4. Two simple or biramous antennules (note that Jurine's antennae/antennules terminology is opposite that of later convention).
5. Eight feet, or swimming feet, outside of the shell.

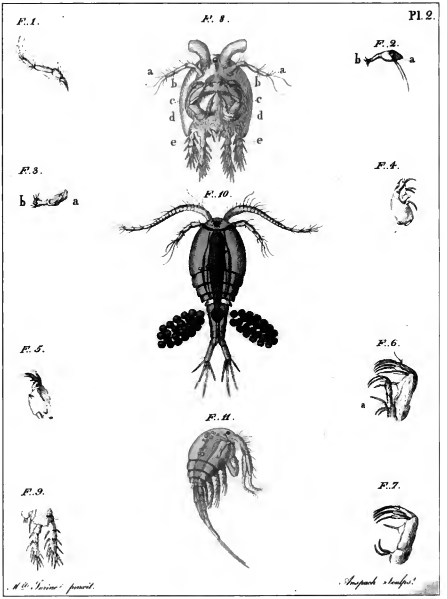
The first species of the first family of the first division was given as *Monoculus quadricornis rubens* (Jurine's Pl. 1 and Pl. 2, figs. 1–9), technically a variety (*rubens*) of the species *quadricornis.* Jurine found this in all the ponds around Geneva. He noted that Müller (1785) had also referred to color variants in *Cyclops,* which Jurine admitted might actually have been new species. However, Jurine did not believe that there was sufficient information to relate those variations to species. His primary species criteria were

1. Permanent color of adult.
2. Size and shape.
3. Manner in which female carries egg sacs.
4. Color of ovaries and color of larvae.

Besides *Monoculus quadricornis rubens,* which Jurine termed a species, he listed four "varieties" (discussed below). By way of explanation for the trinomial, Jurine said that "I have added to the usual denomination of the monocle another name, to distinguish the differences between this species and the others that constitute the remarkable varieties, designated in the remaining part of this work" (Jurine 1820).

Schmeil (1892) was unsure of the identity of Jurine's *Monoculus quadricornis rubens,* but he suggested that it was identical to *Cyclops strenuus* Fischer, 1851. Oddly enough, Jurine's four varieties have fared better; Schmeil considered three of them as valid *Cyclops* species.

Details of Monoculus quadricornis rubens *(Figs. 1–9) and* M. quadricornis albidus *(Figs. 10–11). From Jurine (1820).*



Jurine indicated five synonyms of *Monoculus quadricornis rubens,* beginning with Linnaeus's *Monoculus quadricornis* and including species from Geoffroy, De Geer, and Fabricius, as well as Müller's *Cyclops quadricornis.* This was followed by a long and good description of the adults and larvae.

The descriptions and illustrations of the appendage forms and functions are beyond anything offered up to Jurine's time. He determined that there were five appendage pairs preceding the swimming feet, rather than the present-day six (see his Pl. 2, fig. 8):

1. Antennae, with description of male and female antennae, and role of male antennae in mating.
2. Antennules (Pl. 2, fig. 1) (present-day convention reverses Jurine's terminology of these first two appendages).
3. Internal mandibles (Pl. 2, figs. 2–3) (present-day mandibles proper).
4. External mandibles (Pl. 2, figs. 4–5) (present-day first maxillae).
5. Claws (Pl. 2, figs. 6–7), which Jurine believed to be divided at their base into the internal claws (present-day second maxillae) and the external claws (present-day maxillipeds).

Therefore, Jurine's consideration of five pairs included all maxillae/maxillipeds and very nearly matched the present-day six; it must be remembered that long debate centered about the "real nature" of those pesky maxillae and maxillipeds, and Jurine could never be faulted for his interpretation.

With regard to the swimming feet of this cyclopoid (see his Pl. 2, figs. 8–9), Jurine said correctly that there were four pairs, "not three as Müller had stated." All were segmented, with plumose setae. Jurine reported that the species was carnivorous "by instinct and taste, but herbivorous by necessity." In a drop of water small enough to hold it still, Jurine observed its internal organs, maturing eggs, the contractions of the intestines, and fecal pellets. He could not recognize the heart but assumed that it existed. By tinting the water with ink, he observed that the water did not go in that proportion into the stomach, but that their feeding consisted essentially of "solid molecules prepared by their mastication" (Jurine 1820).

In 1820, only Jurine could fairly be this critical:

> I have examined the drawings that other authors have given of this monocle, without having found one that represents them with exactness and in a satisfactory manner; the tail especially has been poorly drawn, and the particular organs which are found there are completely overlooked. The figure accompanying the short dissertation of Leeuwenhoek (Letter to Royal Society of London, page 142) is crudely done; that of Baker ("Microscope Made Easy" [French edition], page 120) deviates from nature; that of Roesel ("Insectenbelustigungen" 3, plate 98) is pretty but inaccurate; that of Geoffroy ("Histoire abregée des Insectes" 2, plate 21) is worthless; that of De Geer ("Mémoires pour servir à l'Histoire des Insectes" 7, plate 29) is incorrect; that of O. F. Müller ("Entomostraca" plate 18) is the best, but still leaves much to be desired. (Jurine 1820)

Jurine's observations on reproduction, mating, and development of eggs and larvae were exceptional. He noted the connection of the oviduct to the genital segment, including that the number of eggs per sac varied from thirty to forty depending on the female's age. He also discussed both sides of the debate about the species being viviparous or oviparous and concluded the latter, in view of the egg's independence from the female.

Jurine knew of no other investigator before Müller who described and figured the mating of this species. He agreed in general with Müller but added some details. Both workers missed the significance of the spermatophores and their transfer to the female. Because of the fecundity of the females, in spite of the seeming infrequency of coupling, Jurine doubted the necessity of coupling. He thought there might be another method for fertilization of the eggs, one that might even persist beyond a generation.

Jurine reported that the numbers of male *M. quadricornis rubens* were small compared to that of females, by a ratio of one to ten or twelve. He postulated that males might not even be necessary (probably influenced by Bonnet's studies on aphids); females were allowed to develop in isolation from males. Since no fertilized eggs resulted, Jurine concluded that males were necessary but that a single mating may suffice for the life of the female. He remained unsure of the fertilization mechanism.

Another first for Jurine was the publication of extensive journal entries for an assortment of experiments, with replicates, on days between egg-laying, numbers of eggs, and hatching times. He addressed the range in hatching times (two to ten days) and related that to the season (i.e., temperature). Jurine's monograph displays a "Table of Fecundity for *Monoculus quadricornis*" that begins with an average of eight layings, with

40 offspring each, in one female from 1 January to the end of May, resulting in 320 offspring, of which 80 are males and 240 are females. The 240 females (of the "first family") do likewise from 1 April to the end of June, resulting in 57,600 females of a "second family." These expand to a "third family" of 13,824,000 females by the end of September. At the end of December, this last family was responsible for 3,317,760,000 new females. Therefore, adding all males and females, Jurine calculated a year's production at 3,331,641,840 females and 1,110,547,280 males. Few investigators of the early 1800s looked at life in this way:

> It would be nothing less than astonishing if nature was so lavish without the means of destruction to counter-balance such multiplication of this species.
>
> This small animal, which I have said is about 7/12 lines in length, not including the setae on the tail, would easily escape the naturalist's notice if its red shell was not so readily revealed. Unfortunately for it, it has many formidable enemies; voracious insect larvae (tetrapteres) inhabiting the same element, in which all the aquatic beetles and spider-mites wage a cruel war, are the most frequent of this assemblage. With all these animals against them . . . such an immense quantity is swallowed up each day! In spite of all manner of destruction, the number of these monocles does not appear to diminish, which is a sign of their prodigious multiplication. (Jurine 1820)

Jurine acknowledged Leeuwenhoek's account of females eating their young, as well as De Geer's doubt about this. Since, Jurine said, each of those records was based on single observations, he set up a number of experiments to resolve the dispute. Hatching larvae with their confined mother, Jurine noted more than once that the larvae disappeared when they

> fell under the maternal teeth. To speak in favor of the monocle, the mother does not seek to devour her offspring, and this apparent depravity is not voluntary, but only the result of the way in which they feed; in other words, the larvae cannot resist the water turbulence set up by the mother, and they are entrained in the current of the mandibles, which, in truth, are unforgiving. (Jurine 1820)

"Abandoning this unpleasant scene," Jurine returned to the development of the larvae. He was surprised that a naturalist of Müller's stature would have made such a mistake as to conclude that *Nauplius* and *Amymone* were anything but developmental stages of monocles, especially since both Leeuwenhoek and De Geer had correctly reported these larvae much earlier. Jurine's description and figures of the newly hatched copepod larvae are absolutely clear, noting the subsequent changes and the required number of days.

Jurine's comments on the development of cladocerans would have been equally applicable to the copepods:

> What of the new-found thoughts of this simple account! What a vast subject of meditation for the philosopher! What an object of admiration for the naturalists! To see the matter organize itself in this way so to speak before our eyes and to take up life and movement, it is without contradiction the most delightful of all spectacles; also I will never forget the vivid impression that was felt in my soul with the unfolding of these small animals; all the memories of it are delightful, and all of the consequences direct me toward the infinite wisdom of the Creator who presides in the organization of the infinitely small as well as the great. (Jurine 1820)

Jurine's enumeration of the stages is ambiguous. He is not clear on the number of naupliar molts (as we know them now) and refers to the molt from nauplius to copepodid stage as the "premier molt," which could mean either "chief" or "first" molt. He compared "this interesting metamorphosis" to that of insects.

Before completing his "history," Jurine felt obliged to consider what some authors had described as the ability of monocles to withstand prolonged drying, awaiting the return of the wet season. A drying lake, he noted, may lose only the surface water, while the substrate might still be moist. In some cases, however, there could be complete dryness. Since he could not find a natural situation to his liking, he established several "mares en miniature," which he could observe as often as he liked. These "mares artificielles" were given water, marsh mud, algae, and moss, then left to evaporate. Jurine noted that the monocles persisted as long as the mud did not dry out; otherwise, they "perished irrevocably." He concluded from these and other experiments that the "resurrection" of the monocles was erroneous. He was initially unsure of the ability of eggs to resist drying but later found that no dried eggs would hatch.

Jurine's first copepod variety was *Monoculus quadricornis albidus* (in his Pl. 2, figs. 10–11), a more rounded form with a slightly sepia-toned grayish, transparent body. This copepod carried its egg sacs at a greater angle to the tail and was not as common as the red *rubens* species. He found it especially in ponds in the vicinity of Chateau-blanc. Schmeil (1892) described this as *Cyclops albidus* (Jurine, 1820).

The second variety was *Monoculus quadricornis viridis* (in Jurine's Pl. 3, fig. 1), with green body becoming more intense with age due to the "moss" on the shell. It was not as rare as *albidus* but had a similar distribution. Schmeil (1892) believed this to be a valid species, *Cyclops viridis* (Jurine, 1820).

The third variety was the reddish-brown *Monoculus quadricornis fuscus* (Jurine's Pl. 3, figs. 2–4), found in diverse ponds and especially in the pools of the field at Eynard à Malagnoux. Schmeil (1892) also considered this variety as a distinct species, *Cyclops fuscus* (Jurine, 1820).

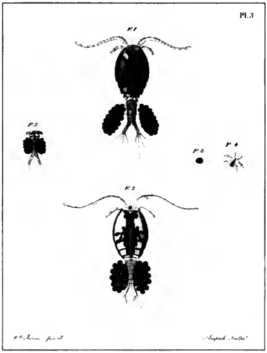
The fourth and last variety was *Monoculus quadricornis prasinus* (Jurine's Pl. 3, fig. 5), a light-green cyclopoid from the ponds at Chatelaine, most numerous in July. Schmeil (1892) thought that this variety might be the same as *Cyclops prasinus* Fischer, 1860.

After this remarkable tour de force with the free-living cyclopoids, Jurine turned to his only calanoid *Monoculus castor* (Jurine's Pls. 4–5), now recognized as *Diaptomus castor* (Jurine, 1820). If one denies Müller's priority on *Diaptomus caeruleus* (most workers have credited the species to Fischer from 1853), Jurine's *castor* is the oldest valid name for a diaptomid species (Schmeil 1896).

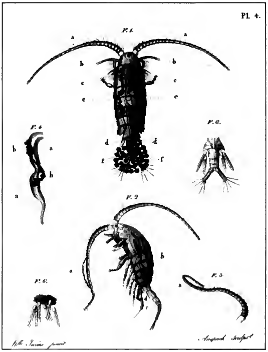
For synonyms of *M. castor*, Jurine indicated *Cyclops caeruleus, C. rubens,* and *C. lacinulatus,* all of Müller. He described the body form (1½ lines long) and its segmentation, pointing out some of Müller's errors. He also mentioned some color changes and seasonal cycles. The species was found in pools of Malagnoux and in the ponds around Chênes.

> This monocle is not rare in our country; many ponds have it in abundance, and I have found it frequently in the running waters of the Rhone. Its bearing is elegant; its manner of darting in the liquid is noble and hardy; its movements are free and easy; everything in short proclaims with it a superiority that characterizes the grandeur of the species to which it belongs.
>
> I have given the name *castor* to this monocle, because the tail of the female, when it bears the egg sac, resembles that of the industrious animal from which I have taken the name. (Jurine 1820)

The terminology of the anterior appendages of *M. castor* differed slightly from that given for Jurine's cyclopoids. There were still a pair each of uniramous



(left) Monoculus quadricornis viridis *(Fig. 1),* M. quadricornis fuscus *(Figs. 2–4), and* M. quadricornis prasinus *(Fig. 5). From Jurine (1820).*



(right) Monoculus castor. *From Jurine (1820).*

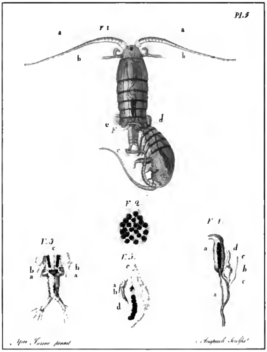
"antennae" (Jutine's Pl. 4, figs. 1–3; Pl. 6, fig. 13) followed by biramous "antennules" (Jurine's Pl. 6, figs. 1 and 13) and the internal mandibles (Jurine's Pl. 6, figs. 2–3 and 13). Instead of external mandibles (as the first maxillae), Jurine defined "the lips and the barbels of the lips" (his Pl. 6, figs. 4–6, 9, and 13). The second maxillae were represented by "the barbels of the claws" (Jurine's Pl. 6, figs. 7, 9, and 13) and the maxillipeds by "the claws" (his Pl. 6, figs. 8–9 and 13).

These definitions were followed by descriptions of the role of the mouth parts in the feeding current and the entrainment of animalcules and other food particles carried to the mouth. Jurine identified the swimming feet (his Pl. 6, figs. 10 and 13), the eye and its muscles, the rapidly pulsating heart (112–120 beats per minute), the reactions of othet organs (Jurine's Pl. 4, fig. 4), and the fleeting mating process with the role of the male first antenna (his Pl. 4, fig. 3) and fifth legs (his Pl. 6, figs. 11–12).

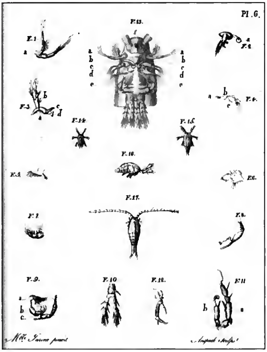
Jurine was not able to determine if a single mating was sufficient for several broods. Even though Jurine believed individuals to be fairly long-lived, three months at least, he could not keep this species alive very well in captivity. In spite of several arrangements, he never saw separate eggs hatch and concluded that the eggs required some maternal influence. Jurine did observe spermatophores attached to females (his Pl. 4, fig. 5, incorrectly labeled fig. 6) more frequently at some times than othets, but he did not believe they had anything to do with the reproductive process. He knew that Müllet, also puzzled, had called them "laciniae," and, like Müller, he thought they might be unique to this species. He then noted that their number was not constant, and, in fact, they were sometimes on the male fifth leg. Jurine came so close to the truth, not revealed until von Siebold in 1839. In the end, Jurine abandoned the spermatophotes, thinking perhaps they were merely sedentary animalcules (his Pl. 4, fig. 6). Not a bad guess.

Experiments similar to those on *M. quadricornis* were generally unsuccessful. Depending on season, eight to fifteen days were required for eggs to hatch. Jurine related color changes to degree of maturity. The larvae developed as in *M. quadricornis*; Jurine stated that nauplii did molt (his Pl. 6, figs. 14–16), but he was not clear on the number of stages. He indicated that twenty-five to twenty-eight days passed until the "premier molt," which, from his figure (see Jurine's Pl. 6, fig. 17), resulted in the first copepodid stage.

The third copepod species described by Jurine was *Monoculus staphylinus* (his Pl. 7), 5/12 lines long, with synonyms of *Cyclops minutus* Müller and *Cyclops minutus* Fabricius. This is now known as the harpacti-



(left) Monoculus castor. *From Jurine (1820).*



(right) Monoculus castor. *From Jurine (1820).*

coid copepod *Canthocamptus staphylinus* (Jurine, 1820) (see Schmeil 1892, 1893). Jurine said he changed the name from Müller's *Cyclops minutus* because there were many monocles even more "minute," and that this species never moves without recurving its posterior toward the anterior, in the manner of a common beetle, the "staphylin." He found it to be fairly common, although difficult to see, in the mud and on the surface of algae in the smallest ponds and springs, especially at St. Jean, Champel, and Chênes. To Jurine, this animal bore little resemblance to the monocles he mentioned previously; he noted, for example, that the body flexion was between different segments. Also, it moved through the water with more flexing, and not by darting.

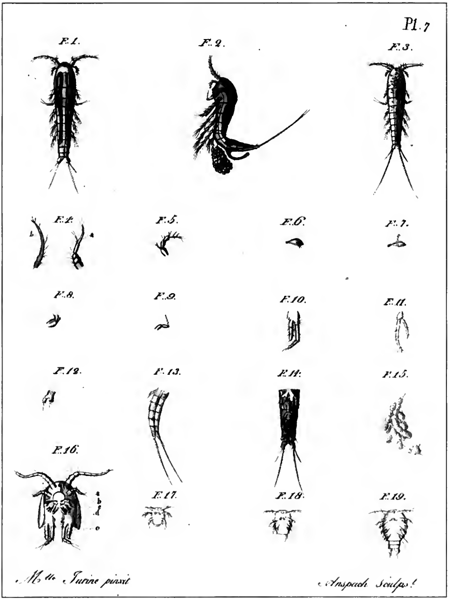
Jurine said the male (see his Pl. 7, figs. 3 and 13) was much smaller than the female (see his Pl. 7, figs. 1–2 and 14), and of a pretty rose color, while the female was aquamarine blue or bluish-green. He described and figured the mouth-parts (his Pl. 7, figs. 4–9 and 16), using the same terminology as with *M. castor*, missing only the second maxillae that he thought were a part of the first maxillae. These were followed by four pairs of long swimming legs (see his Pl. 7, figs. 10–12 and 16).

If captive females abandoned their egg sacs within a few days of laying, the embryos died. But if the eggs were old enough to have a rose tint, then the larvae would hatch normally (Jurine's Pl. 7, fig. 15). This proved to Jurine that the maternal influence could not completely be dispensed with, in spite of the egg sacs being on a very slender stem.

Jurine said that a look at the various larval stages would easily expose Müller's error in the interpretation of *Nauplius* as an adult form (see Jurine's Pl. 7, figs. 17–19). Jurine (1820) incorrectly recorded only five molts after hatching, at several-day intervals, "after which it has all its parts."

Jurine then described with equal clarity and depth sixteen species of cladocerans and eighteen species of ostracods. The last section of his monograph dealt with the fairy shrimp. Although this last is not a copepod, I am compelled to include Jurine's account of his acquisition of these graceful animals: "After having ended my researches on the monocles, I read in the Journal de Physique of July 1803, the dissertation that my countryman Bénédict Prévost, resident then at Montauban, had published on [*Chirocephalus*]." Since Jurine did not know of this species, he wrote to Isaac Bénédict Prévost (1755–1819) to ask for some eggs, which he received on 5 April 1804. The eggs had been en route for six days and were wrapped in moist paper. They had been laid 24 March, and on 10 April the larvae appeared: "I found myself therefore the possessor of a great number of these small animals. Over the next nine months, I examined these with great attention, and my daughter drew each day that which was especially interesting to us" (Jurine 1820).

Obviously, Jurine's daughter's component of this work was a major contribution. Jurine said that his journals and his daughter's drawings remained in a portfolio until 1814, when he was visited by Prévost and then made firm arrangements for publica-



Monoculus staphylinus. ***From Jurine (1820).***

Monument to a Much-Loved Daughter

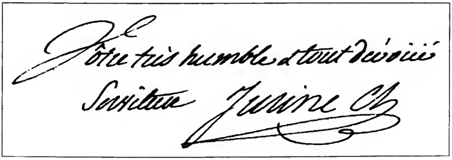
tion. Baird (1850) referred to Jurine's "accomplished daughter," who "faithfully portrayed [the Entomostraca], as seen by the microscope." The quality of her artwork and her character earned her the admiration of many:

> Since the famous Marie Sybille de Merian [1647–1717] crossed the seas in 1699, to observe and paint insects from Surinam, Mad.^{elle} Jurine is perhaps the person of her sex who has the most merit as a naturalist by her numerous drawings relative to Natural History. She unites the talents of an artist with the art, more difficult than you would imagine, of a good observer; also, her drawings are not recommended any less for their elegance as for their rigorous exactness. M. Jurine has said more than once, to some of his friends, that when laboring on the publication of his work on the "History of the Monocles," rather than viewing it as a personal advancement, he envisioned a monument to his much loved daughter, who had participated in all the work on natural history. Mademoiselle Jurine joined her distinguished talents to her most amiable qualities of spirit and perfect virtues. When her mother became an invalid, the touching care she gave to her, and the extreme earnestness which she attended to the illness which carried her away, visibly attacked her health, in other respects very delicate; in fact, she did not survive five weeks beyond her mother, and her death before reaching 37 years, plunged her sad father into a most profound affliction. (Note from the Editors, Jurine 1820)

Jurine had one surviving son who was the caretaker/ proprietor of the large baths of Tivoli in Paris; a grandson in Geneva was reported to have an interest in natural history (Anon. 1820a), but this promise was not fulfilled (Sigrist 1995). (Jurine's younger son, André, a physician-friend of Delaroche, was introduced in Chapter 10.)

Jurine's final written words were:

> I cannot end this Preface without going to the tomb of my illustrious compatriot [Charles Bonner] to offer the expression of my ardent gratitude. It is you who inspired in me the love of the study of nature; it is the reading of your works that introduced me to this interesting career; it is you who sustained me by your encouraging words. "I would consider myself especially well rewarded in my work, if those of my compatriots who appreciate Natural History would, by my example, take up the Insects. They will certainly make many curious discoveries; their success that comes with an effort even as weak as mine, will be assured" [from Bonnet's "Works on Natural History and Philosophy," 1779].
>
> Ah! if you have bequeathed to me the sublime touch with which you represented Nature; if I can entertain and instruct as you; if I am able as you to affect the spirit and excite admiration for the wonders of the Creator, I trust this success will reflect upon you. But alas! I have far to go to claim that. (Jurine 1820)


Votre très humble et tout dévoué
Serviteur Jurine Ch

Louis Jurine (1751–1819) and signature of "Jurine, Surgeon." Courtesy of Bibliothèque Publique et Universitaire, Geneva, and François Martin, photographer.

Anselme Gaetan Desmarest (1784–1838). Courtesy of the Wellcome Institute Library, London; signature courtesy of the Museum of Natural History, Le Havre.

ANSELME GAETAN DESMAREST
(Zoologiste),
Membre correspondant de l'Académie des Sciences
de Paris, Professeur à l'Ecole-vétérinaire d'Alfort,
Membre titulaire de l'Académie royale de Médecine &c.
Né à Paris le 6 Mars 1784.

Claus (1866) intended to honor Jurine with the copepod genus *Jurinia*, a name already used a generation before for an insect. To remedy this inadmissible double honor, Wilson (1924) substituted for the copepod a new genus, *Lourinia*, derived from Jurine's first name.

* * *

The decade of the 1820s saw surprisingly little by way of new studies on free-living copepods. The sun virtually rose and set with Jurine's (1820) masterpiece. Midway through the decade, Desmarest (1825) provided a giant step for Crustacea in general by respectably summarizing all that was known to that point. Desmarest's comments on the enigmatic parasitic copepods will be mentioned in Chapter 14, dealing with the slow revelation of these copepods' ties to crustaceans.

Anselme Gaetan Desmarest

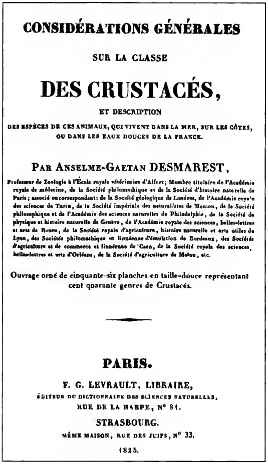
6 March 1784–4 June 1838

Anselme Gaetan Desmarest was born in Paris, the son of Nicolas Desmarest, a member of the Academy of Sciences and student of the physics of earthquakes and volcanoes (Blanchard 1838, Agassiz 1850). The younger Desmarest received early schooling at the Prytanée Français, a military school. At the age of sixteen, he began to specialize in mathematics, winning a medal of honor with a small annuity paid until the Restoration. At this time he also finished a topographic chart of the Auvergne region that his father had begun.

Desmarest's studies led him to Cuvier, who must have considered the young man a pupil worthy of particular attention and support. Desmarest went over completely to natural history and began his varied publications on its subjects around 1805. He also formed a lifelong friendship with Lesueur, which included joint publications in 1814 and 1815 on fossils and tunicates (as mollusks) (Bonnemains 1989). In 1822, Desmarest named a fossil spiny lobster *Palinurus sueuri* after his colleague.

Desmarest also formed a close relationship with Latreille and ultimately worked with him for many years on the editing and writing of crustacean and other sections of the *Dictionnaire des Sciences Naturelles*. In 1814, Latreille was the Professor of Zoology at the Veterinary School at Alfort, and Desmarest followed him there for supplemental studies. Latreille resigned in 1815 and was replaced by Desmarest, who retained the position for the rest of his relatively short life. In 1825, a reorganization of the school did away with the zoology chair, but Desmarest was retained in the same capacity as Professor of Animal Physiology and Botany (Blanchard 1838).

We have already reviewed Bosc's (1802) landmark work on Crustacea. This was considered part of the twenty-four-volume *Nouveau Dictionnaire d'Histoire Naturelle*, certainly very familiar to the young Desmarest. By 1816, the second edition of the *Dictionnaire* (with a final thirty-six volumes) was in preparation, with the crustacean sections edited by Latreille and, later, also by Desmarest. It is this version that held the influential contributions by Leach (1818, 1819). Desmarest (1825) recalled these contributions and how he himself became entwined with the general work on crustaceans:



CONSIDÉRATIONS GÉNÉRALES

SUR LA CLASSE

DES CRUSTACÉS,

ET DESCRIPTION

DES ESPÈCES DE CES ANIMAUX, QUI VIVENT DANS LA MER, SUR LES CÔTES,
OU DANS LES EAUX DOUCES DE LA FRANCE.

PAR ANSELME-GAETAN DESMAREST,

Professeur de Zoologie à l'École royale vétérinaire d'Alfort; Membre titulaire de l'Académie royale de médecine, de la Société philomathique et de la Société d'histoire naturelle de Paris; associé ou correspondant: de la Société géologique de Londres, de l'Académie royale des sciences de Turin, de la Société impériale des naturalistes de Moscou, de la Société philosophique et de l'Académie des sciences naturelles de Philadelphie, de la Société de physique et histoire naturelle de Genève, de l'Académie royale des sciences, belles-lettres et arts de Rouen, de la Société royale d'agriculture, histoire naturelle et arts utiles de Lyon, des Sociétés philomathique et linnéenne d'émulation de Bordeaux, des Sociétés d'agriculture et de commerce et linnéenne de Caen, de la Société royale des sciences, belles-lettres et arts d'Orléans, de la Société d'agriculture de Melun, etc.

Ouvrage orné de cinquante-six planches en taille-douce représentant
cent quarante genres de Crustacés.

PARIS.

F. G. LEVRAULT, LIBRAIRE,
ÉDITEUR DU DICTIONNAIRE DES SCIENCES NATURELLES,
RUE DE LA HARPE, N° 81.
STRASBOURG.
MÊME MAISON, RUE DES JUIFS, N° 33.
1825.

Title page of Desmarest's Considérations générales sur la Classe des Crustacés *(1825).*

The English scholar William Elford Leach was given the charge in 1816 to compile the part of the "Dictionnaire des Sciences Naturelles" relative to Crustacea. Already a great many articles had been introduced (including "Entomostraca"), until a cruel malady unexpectedly interrupted his work, which has been indefinitely postponed.

Meanwhile, the printing of the "Dictionnaire" continues, but slowly; and so as not to completely stop this vast enterprise, in an imperious sense, one needed to look at a variety of authors of articles on carcinology, with the attendant necessity of correspondence regarding their articles and notes, all extending the time for, or even stopping, the production.

After four years of vain hope, the health of Mr. Leach has sadly not improved, and the editor of the "Dictionnaire des Sciences Naturelles" was forced to make a decision respecting that part which delayed all the others. He engaged me to continue, leaving me free to choose the means which seemed the best under the circumstances.

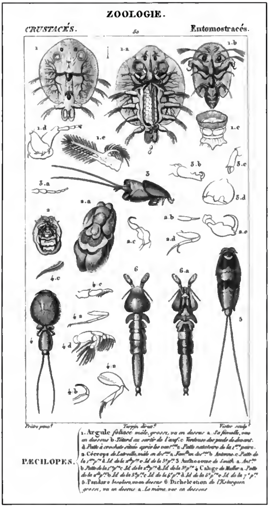
Mr. Leach had been pressed for time when he had undertaken to publish the "Dictionnaire . . . " jointly with learned professors, and so he could only skim the material which he had developed for the article "Crustacea." He did not try to present a thorough analysis of the principal systems of classification proposed by several celebrated naturalists, like Linne, Fabricius, Latreille, and de Lamarck. (Desmarest 1825)

Desmarest, having accepted the mission to complete Leach's task, then listed the subjects that he deemed necessary in a comprehensive work on Crustacea, including "a complete history of this science, to discern its successive progress, only reviewing the part treated by Leach, filling up the spaces which he has neglected to occupy, and exposing that which has taken place since the sad epoch for which he has himself contributed illustration" (Desmarest 1825).

Particular points that Desmarest emphasized were the descriptive details of genera and the review of publications not known to Leach, especially the contemporary works of Latreille, Lamarck, Jurine, and Say. Desmarest accepted Leach's principal crustacean classification, into subclasses Malacostraca and Entomostraca, but considered in addition the tribes and families of Latreille. He stated that he believed in a "sensible, natural, and comparative system."

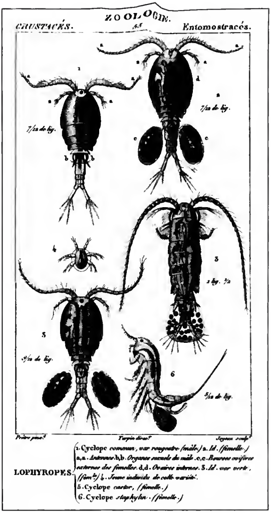
While Desmarest was providing new information for the encyclopedic series, Duméril near the end of 1823 published a comprehensive entomological work based on his contributions to the *Dictionnaire.* The general editor then suggested that Desmarest prepare an analogous work on crustaceans, a proposition he readily agreed to. This, the grand *Considérations générales sur la Classe des Crustacés . . .* of 1825, paraphrased Duméril's title and incorporated Duméril's style.

Desmarest's (1825) first chapter discussed the position occupied by crustaceans in the scale of existence ("l'échelle des êtres"). Successive chapters dealt with details of external and internal structure as well as functions of organs, habits, uses by man (only one page), classification systems, and descriptions of taxa; it included a superb bibliography. The drawings, of examples from 140 genera on fifty-six copper plates, were done "by a clever painter and good observer, Mr. Pretre, under the direction of the scholar botanist and draftsman Mr. Turpin." Where



1. Argule *foliacé mâle, grossi, vu en dessus* a. *Sa femelle, vue en dessous* b. *Têtard au sortir de l'œuf.* c. *Ventouse des pieds de devant.* d. *Patte à crochets située après les vent.ses* e. *Patte natatoire de la 1.re paire.* 2. Cécrops *de Latreille, mâle en dess.us* a. *Fem.lle en dess.us* b. *Antenne.* c. *Patte de la 1.re p.re* d. *Id. de la 2.e p.re* e. *Id. de la 3.e p.re* 3. Anthosome *de Smith.* a. *Ant.re* b. *Patte de la 1.re p.re* c. *Id. de la 2.e p.re* d. *Id. de la 3.e p.re* 4. Calige *de Muller* a. *Patte de la 2.e p.re* b. *Id. de la 3.e p.re* c. *Id. de la 4.e p.re* d. *Id. de la 5.e p.re* e. *Id. de la 7.e p.re* 5. Pandare *bicolore, vu en dessus* 6. Dichelesthion *de l'Esturgeon grossi, vu en dessus* a. *Le même vue en dessous*

Cecrops *(Fig. 2)*, Anthosoma *(Fig. 3)*, Caligus *(Fig. 4)*, Pandarus *(Fig. 5)*, *and* Dichelesthium *(Fig. 6)*. *From Desmarest (1825).*



1. Cyclope *commun, var. rougeatre (mâle.)* 2. *Id. (femelle.)* a,a. *Antennes.* b,b. *Organes sexuels du mâle.* c,c. *Bourses ovifères externes des femelles.* d,d. *Ovaires internes.* 3. *Id. var. verte, (fem.lle)* 4. *Jeune individu de cette variété.*
5. Cyclope *castor, (femelle.)*
6. Cyclope *staphylin. (femelle.)*

Several species of "Cyclops." *From Desmarest (1825).*

generic names were redundant, Desmarest indicated synonyms and generally retained the oldest.

In five foldout "grand tableaux," Desmarest reviewed the major classification systems for all genera described from 1735 to 1823. For the first epoch, that of Linnaeus, Desmarest listed the venerable *Cancer, Oniscus,* and *Monoculus,* saying that the genera "now number 80-times more." In the forty years after Linnaeus, he judged that the number was stable but that "Fabricius from Kiel" then added four more. Fabricius, who Desmarest acknowledged as a friend, raised the total number to 12 by 1793. Oddly, Desmarest did not at that point enumerate the genera added by Müller. He noted that Lamarck counted 36 crustacean genera in 1801, while Latreille admitted 64 in 1806. This was followed in six or seven years by the first works of Leach. In the ten years after Leach, Desmarest emphasized that four-fifths of the 315 generic names he discusses (unique as well as duplicates) had been proposed.

Understandably, Desmarest's great work had a French focus. Each genus was characterized and illustrated by at least one species

> found upon the shores of our seas or in our fresh waters, running or stagnant, or also some Crustacea observed only on England's coast, but perhaps some day encountered upon our shores.
>
> The parts of this work that differ most from the "Dictionnaire . . . " include . . . the entire subclass Entomostraca, particularly the orders Poecilopa and

> Lophyropa. The Entomostraca are the object of new divisions which we sadly cannot include. (Desmarest 1825)

What Desmarest did include for the Entomostraca was fairly solid for his time, and, as we shall see in the next chapter, he gave a very enlightened eleventh-hour account (as a footnote) of the position of the lernaeids (in the broad sense) relative to the other groups:

- Subclass Entomostraca [following the Subclass Malacostraca]
  - Order 6. Poecilopoda (of Latreille)
    - Division 1 (= Family Argulidae Leach), with *Argulus* Müller (illustrated)
    - Division 2 (= Family Caligidae Leach), with *Anthosoma* Leach (illustrated), *Dichelesthium* Hermann (illustrated), *Cecrops* Leach (illustrated), *Pandarus* Leach (illustrated), *Nogaus* Leach, *Caligus* Müller (illustrated), and *Risculus* Leach. Desmarest tentatively placed the lernaeids in this division.
    - Division 3 (= Family Limulidae Leach), with the king crab *Limulus.*
  - Order 7. Phyllopoda (of Latreille), with the branchiopod *Apus*
  - Order 8. Lophyropa (of Latreille)
    - Division 1 (= Family Cyclopidae Leach), with *Cyclops* Müller and its synonyms, including three species (illustrated) and synonyms, and also *Calanus* Leach with only *Calanus finmarchicus,* confounded as usual with *Cyclops longicornis* Müller.
    - Division 2 [two Leach families now placed with ostracods and cladocerans]
  - Orders 8 and 9 comprised most of the ostracods and branchiopods.

We have already examined Desmarest's coauthorship of the second edition (1830) of Bosc's small-format "Natural History of Crustacea." In addition, Desmarest had several significant encyclopedic entries regarding mammals; Agassiz (1850) listed about twenty-five other publications treating such diverse subjects as geology, anatomy, birds, fish, mollusks, insects, and trilobites.

Desmarest was a member or corresponding member of many scientific societies, proudly listed on the 1825 title page. He was a corresponding member of the Academy of Sciences, a long-time Secretary of the Société Philomatique, and an honorary member of the Entomological Society of France (Blanchard 1838). No doubt his relationship with Lesueur led to his corresponding associations with the Philosophical Society and the Academy of Natural Sciences of Philadelphia.

Desmarest worked right up to the end, keeping abreast of contributions in his fields; he left unfinished a revised encyclopedic work on fishes: "This modest scholar and distinguished professor . . . worked for the love of science, not for ambition, and still less for fortune. He was extremely affable, and animated in instruction and conversation" (Blanchard 1838).

Desmarest had been in poor health for some years, probably with tuberculosis. He died in Alfort in 1838.

John Vaughan Thompson

19 November 1779–21 January 1847

John Vaughan (J. V.) Thompson lived as a young man at Berwick-upon-Tweed (pronounced "BERick," renowned in the next generation with Wm. Baird), an area apparently conducive to the encouragement of naturalists and in particular Thompson's earliest interests in botany. By 1799 he had acquired enough knowledge of medicine to secure his appointment as a regimental assistant surgeon. By 1803 he had advanced to surgeon. While at Cork, Ireland, the location of his most famous discoveries, he rose to the senior rank of deputy inspector of hospitals. He left Cork in 1835 to become the chief medical officer of the convict settlement at New South Wales, where he died in Sydney in 1847 (Wheeler 1968).

J. V. Thompson first came to the notice of zoologists with the 1827 publication of "A Memoir on *Pentacrinus europaeus*: A Recent Species Discovered in the Cove of Cork." This was the first of several privately published reports whose rarity kept them from the wide circulation they deserved, although this first one was not in the more famous *Zoological Researches* series. *Jameson's Edinburgh New Philosophical Journal* favorably reviewed Thompson's important work:

> Until the publication of this valuable Memoir, Naturalists were acquainted with but one living species of this very rare and curious tribe of invertebrate animals.—The remarks in the Memoir, in reference to the fossil animals of this group, are deserving the attention of the Geologist; and the neatly executed accompanying Plates add to the value of these and other observations of our Author. We are happy to find Mr. T.

> is about to publish, in a series of numbers, accompanied with figures, a work entitled Zoological Researches and Illustrations, which judging from the present Memoir, promises to add much to our knowledge of the Natural History of the tribes of animals to which Mr. T. has devoted his attention.[2]

The reviewer had no idea how very much would be added. The reference to the first and startling record of living crinoid echinoderms was to that of Michael Sars, a copepodologist who has been mentioned previously and will be discussed in his turn with reverence and detail.

J. V. Thompson will be remembered not as the army surgeon, but for his pioneer natural history studies. Army postings placed him far and wide, in the West Indies, Gibraltar, and Madagascar; his instinctive ability and observations as a field naturalist led to membership in the Linnean Society. Thompson's glory came at Cork, in southern Ireland, where he was sent in 1816 (Winsor 1969). Cork is at the head of a long harbor, fifteen miles from the Atlantic Ocean, and is probably one of the best places from which to look upon the new world of the yet-to-be-named plankton:

> On that day April 28, 1823, devoted to the investigation of some marine productions, [the author] was returning home without any addition to the stock of knowledge, when casually throwing out a small muslin towing net on crossing the Ferry at Passage, such a capture of minute animals was made as furnished a treat which few can ever expect to meet, and could hardly be excelled for the variety, rarity, and interesting nature of the animals taken. Some of them never before met with but in the great Ocean . . . others previously seen by a solitary observer . . . and almost lost sight of by Naturalists and excluded from their works; others actually inhabitants of fresh water and quite accidental . . . some not commonly observed . . . others perfectly nondescript and incapable of being associated in any of our classifications of the Crustacea; . . . besides these were many others of inferior note, as Cyclops . . . &c. (Thompson 1830)

At that time the ocean and, in particular, its drifting organisms were virtually unstudied, and few suspected that the strangely shaped organisms in the plankton were larval stages.

The story of Thompson's discovery of crab and barnacle larvae has been told often and well (Hardy 1956, Wheeler 1968). He was probably the first to make methodical use of plankton nets (from 1816); he kept some of the most curious organisms alive in containers and observed their metamorphoses into common animals. Thompson introduced these transformations in a series of six memoirs, published during 1828–1834:

> The Author having devoted no small portion of his time, his means, and his faculties to these Memoirs, which embrace a great variety of subjects interesting to every lover of Nature, hopes that he may be enabled by the countenance and support of Naturalists generally, to carry it on without difficulty or interruption; he therefore entreats all those who may feel disposed to favour a design to extend the limits of Natural Knowledge, to send in their names for copies at their earliest convenience. (Thompson 1828)

Most zoologists were surprised if not skeptical, especially regarding the barnacles—undreamed of as crustaceans. Apparently the response was bleak, few having the desire "to extend the limits of Natural Knowledge," as indicated by the few copies printed. If the mainstream naturalists had known to what extent these limits were to be extended, the good surgeon Thompson would have received a great deal more respect. His solution to the ancient riddle of the barnacles is a zoological milestone (Heron-Allen 1928). And his studies of decapod development changed forever the way these animals are classified and perceived.

Thompson (1828) knew that the absence of metamorphosis marked a principal distinction between the higher crustaceans and insects, referencing in particular the definitions of his countryman Leach. He knew, on the other hand, that some lower crustaceans, like the "Linnean Monoculi," including *Cyclops,* did show metamorphosis.

Following J. V. Thompson's publications, J. O. Westwood, a notable British entomologist (whom we will meet as a part-time copepodologist) denied that there was metamorphosis in the higher crustaceans (Malacostraca) and so rejected Thompson's findings with the crabs (Winsor 1969). The eminent Milne Edwards also doubted the possibilities; he cited species within his own experiences, such as the crayfish, where there are in fact no such profoundly changing larval stages. No doubt Milne Edwards had had his eyes opened by the disclosure that delivered parasitic copepods from the zoophytes/worms, but he nevertheless was reluctant to clasp Thompson's findings. Within a few years, however, after Thompson's experiments had been repeated by others, these metamorphoses became part of the zoological creed. Thompson by that time had gone to Queensland, Australia, never to return. Even Milne Edwards (1850) finally agreed to the realities and professed the now obvious closeness of barnacles to copepods.

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[2] Quoted from the back cover of a Thompson (1829) in my possession.

The deferred endorsement of Thompson's wonderful studies is mostly blamed on the scarcity of his principal publications: "His classical discoveries were described in privately printed memoirs which he published in Cork; they are among the rarest items of biological literature" (Hardy 1956). However, the slow acceptance of Thompson's discoveries is not that easily explained, since he summarized his findings, including those on barnacles, in the *Philosophical Transactions* and the *Entomological Magazine* in 1835-1836 (Winsor 1969). He also received rave reviews in *Literary Gazette, Edinburgh New Philosophical Journal,* and *Zoological Journal.* With Thompson's revelations of barnacle affinities, decapod larval development, and the animal nature of zoophytes, seldom have more zoological oxen been gored so quickly; probably the main onlookers were simply not yet ready. By today's standards, Thompson was the quintessential amateur, but it is doubtful if this was held against him because so many of his contemporaries were of the same cloth. Thompson was willing, if not eager, to extrapolate broadly on the observations of a few species. However, he followed his *Memoirs* with journal articles about metamorphoses in other species. Recognition of the facts, and credit to Thompson, should have come sooner.

That J. V. Thompson was a naturalist of broad genius is evident also in several incidental, almost offhand, remarks within his memoirs. He was fifty years ahead of others in his understanding of the difference between oceanic and near-shore production, and in his perception of the food-chain base in plankton. His appeal for the routine use of plankton nets was not only original, it is positively modern in its concept.

The beautiful Victorian bookplate in my copy of Thompson's original memoirs reminds me of the role simple fate plays in the survival of these time-honored books: "Norfolk and Norwich Library. . . . This Book is part of the Salvage from the Fire which occurred on August 1st, 1898." The Guardian of Rare Books was looking out for this one, since it now neither smells of smoke nor mildew. Similar, and worse, experiences befell Dana's plates for the U.S. Exploring Expedition crustaceans, and incomplete copies are so labeled. Likewise, some of the *Challenger Reports,* which sank to the sea floor, were recovered, reclaimed, and relabeled. The ultimate accolade was conferred on Thompson when his memoirs were reprinted 140 years later as a jewel of zoological literature (Wheeler 1968).

One of the most kaleidoscopic copepods was first brought to science, and named, by Thompson (1829). The prolonged and roundabout way this copepod wandered toward respectability, and its association with the first use of the plankton net, is best told by Thompson:

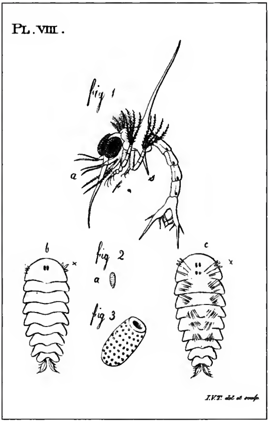
> I had . . . an occasion to witness and to investigate [the third kind of luminosity] as it occurs in the Mediterranean. Returning from a fishing party *late* in a still evening across the bay of Gibraltar, in a direction from the Pomones river to the old Mole, in company with Dr. Drummond, (now Professor of Anatomy to the Belfast Institution) and a party of naval officers, the several boats, although separated a considerable distance, could be distinctly traced through the gloom by the snowy whiteness of their course, while that in which we were, seemed to be passing through a sea of melted silver; such at least was the appearance of the water, displaced by the movement of the boat and the motion of the oars; the hand, a stick, or the end of a rope, immersed in the water, instantly became luminous and all their parts visible, and when withdrawn, brought up numerous luminous points less than the smallest pin's-head, and of the softest and most destructible tenderness. (Thompson 1829)

After reference to similar observations by others, from China, New Holland (Australia), India, and West Africa, Thompson continued:

> These are all the recorded instances of this very remarkable kind of phosphorescence having been seen; it is therefore almost unnecessary to say, that the attention of voyagers should be given to it whenever it is met with, and to the animal or animals which appear to cause it, none of which have been satisfactorily described; this may be done by preserving some of the water until next morning for due investigation, or by straining a portion of it and preserving the filter in a

well-closed vessel of common spirits, until subjected to the scrutiny of some qualified naturalist.

The other kind of luminosity of a more local nature, is that which presented itself to the observation of Captain Horsburgh, a gentleman richly entitled to National Honours and to the gratitude of posterity, for his valuable contributions towards the safe navigation of a large portion of the trackless Ocean. His example in the present instance deserves to be imitated. At sunrise on April 12, 1798 in the Arabian Sea, he perceived several luminous spots in the water, which conceiving to be animals, he *went in the boat,* and caught one: it proved to be an insect somewhat resembling in appearance the wood-louse, (Oniscus) and was about one third of an inch in length. When viewed with a microscope it seemed to be formed by sections of a thin cutaneous substance.— "During the time that any fluid remained in the animal it shone brilliantly like the fire-fly." Taken from his notes given to Sir Jos. Banks, as quoted by Prof. Macartney, *Phil. Trans.* 1810. who has appended to his paper, Pl. XV. f.4, an engraving of the animal copied after a pen-sketch by Captain Horsburgh. Having had the good fortune to meet with this same animal (Pl. 8. f.2.a.b.c.) by day light while in soundings near to the Belliqueux Shoal, which lies off the South extreme of the island of Madagascar, and again on the Agullas [*sic*] Bank near to the Cape of Good Hope, August 9th, 1816, I am entitled to say that it is no Limulus as suggested by the learned Professor, and although not sufficiently scrutinized by me to determine its actual structure, is an animal which it is impossible to associate with any other genus of the Crustacea. Individually I feel under great obligations to this beautiful little animal, which by its splendid appearance in the water induced me to commence the use of a muslin hoop-net, which when it failed to procure me a specimen, brought up such a profusion of other marine animals altogether invisible while in the sea, as to induce a continued use of it on every favorable opportunity. The *Sapphirina indicator,* which is the name I propose for this animal which is so beautifully luminous by night, by day resembles the finest Blue Sapphire in colour, with the opalescence of the Moonstone or precious Opal, and although but one third of an inch in length, this colour (which is thence probably a modified phosphorescence) pervades the surrounding element so as to give the animal the appearance of being round and of the size of a livre or rupee when seen from the deck of a vessel, appearing larger in proportion to its distance below the surface. . . . If this animal is elegant when viewed by reflected light, it puts on a still more extraordinary appearance when the light is transmitted through its body to the eye of the observer; by a direct light of this kind it resembled the Fire-stone, with tints of yellow, and by a less vivid and indirect illumination it assumed varied intermingled tints of orange, rose, blue, and green of a metallic splendor, and impossible

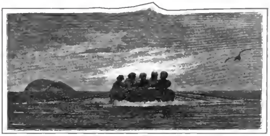


Sapphirina indicator *(Fig. 2). From Thompson (1829).*

PLATE VIII. Fig. 1. The Zoea of the common crab, (Caucer pagurus,) magnified. Near the letter *f* it is represented of its natural size ; *a*, antennæ ; *f*, feet ; *s*, one of the lateral spines.

Fig. 2. Sapphirina ; *a*, natural size ; *b*, magnified, from above ; *c*, magnified, from beneath ; ×, trifid anterior members.

Fig. 3. Pyrosoma pygmæa.



> to imitate. The body of the Sapphirina, which is much depressed, is composed of nine segments; of these, the anterior is the largest, . . . and presents towards its middle part the appearance of a pair of proximate eyes; the posterior segments diminish in width as they approach the opposite end or tail, and the last of them is terminated by two elliptic fins or scales, setaceous on their outer edge and having a central longitudinal nerve or rib. The Sapphirina swims in all directions with apparent ease by the motion of its tail, and often darts away by some sudden effort of its concealed members. There can be no doubt of this animal belonging to the Monoculi of Linnaeus, and most probably to the same family with Cyclops, a relationship which will be more apparent, when we become acquainted with the structure of a nondescript member of it lately detected in our own seas, and which it is intended to develope in a succeeding Memoir. The geographical distribution of the Sapphirina appears to be limited to the seas situated to the north and west of a line drawn from the Cape of Good Hope to the southern extremity of the Island of Ceylon. (Thompson 1829)

Thompson was right in that his new copepod could be placed in no known genus; *Sapphirina* remains firmly in the copepodologist's pantheon. Unfortunately, *S. indicator* was not embraced by subsequent workers (perhaps due to the rarity of Thompson's papers) and was not later distinguished from other *Sapphirina* species from the Indian Ocean. In effect, like Linnaeus's *Monoculus quadricornis,* it received a kind of pocket veto. It is hoped that Captain Horsburgh fared better and eventually received a measure of national honor.

As to why *indicator,* Thompson wrote a very appealing argument—as good as any for his time:

> Meditating upon this subject, I think it not improbable, that the Deity, who has done nothing in vain and whose Omniscience extends to every epoch, foreseeing that man would invent the means of tempting the trackless ocean, and explore the most distant regions of our Planet, has given it as one means of rendering his nights less gloomy, and of diminishing the number of his dangers; especially if we consider, that this luminosity is seen only in the night season, is vivid in proportion to the darkness, disappearing even before the feeble light of the moon, and also, that it increases with the agitation of the sea, so that during the prevalence of storms it greatly diminishes the dense gloom which at such times is often impenetrable to the moon or stars, throws such a light upon the Ship and rigging as to enable the sailors to execute their allotted tasks with certainty, and at all times points out to the cautious mariner the lurking danger of sunken rocks, shoals, and unknown coasts, by the phosphorescent or snowy appearance which it gives to the Breakers, so as to render them visible at a considerable distance; where again the diffused luminous appearance of the Sapphirina indicator is seen, he may be certain that he is in soundings, and probably at no great distance from some fatal spot. (Thompson 1829)

Of his methods, seen in part above, Thompson left uncommonly clear narratives:

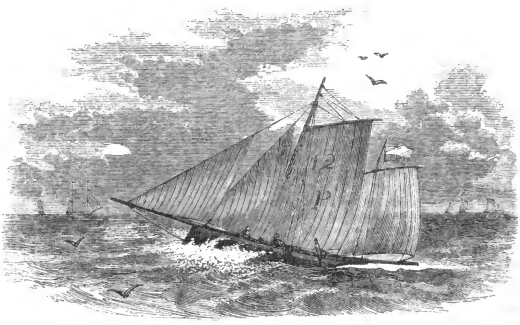
> The Naturalist . . . must use the greatest diligence, seizing every opportunity when the way of the ship does not exceed three or four miles per hour, to throw out a-stern a small towing net of gause, bunting, or other tolerably close material, occasionally drawing it up, and turning it inside out into a glass vessel of sea water, to ascertain what captures have been made; when a ship goes at a greater rate, and in stormy weather, a net of this kind might be appended to the spout of one of the *sea-water* pumps, and examined three or four times a day, or oftener, according to circumstances. (Thompson 1828)

On the back cover of Thompson's penultimate memoir, in 1830, was a notice that he intended to publish additional memoirs on eighteen subjects, including "1.—Structure, natural history, and *metamorphosis* of the Caligi of Entomostraca." He had noted in the previous memoir: "It may be observed that the males of many Crustacea are remarkably less in size and different in aspect, as in the Caligi . . . and also that in some they are rarely met with, and only at a particular season" (Thompson 1830). This was already too late to be revolutionary, but only just barely. That Thompson never had the time, energy, or opportunity to produce this memoir is a misfortune for our science. It can only be imagined what an advance it would have been. Thompson left some unpublished notes that listed, among other species, *C[aligus] scombri* found off southern Ireland on an unidentified host. Since no description or figures were given, the record has no taxonomic precedence over this name used many years later by Bassett-Smith (Kabata 1979).

Another planned memoir was "14.—Structure and metamorphosis of some of the marine Cyclopes, singular varieties in the organization of different genera, etc." This also was not completed; it would have been the first of its kind, a small monograph limited to the free-living marine copepods. Thompson's memoirs averaged thirty to forty pages, with four to six plates; with this scope of detail in mind, such publications were not seen until the 1840s, in the work of Dana, Krøyer, Milne Edwards, and Philippi.

* * *

The 1820s strangely saw little work on the free-living copepods. The highpoint of the decade was reached early with Jurine's (1820) masterpiece. Desmarest's (1825) tour de force added little that was new in this area, but it was a very useful and influential summary of the wider field. J. V. Thompson affixed "numerous luminous points" to marine zoology, including the indelible copepod genus *Sapphirina.* More effort was placed at this time on the parasitic copepods, as they moved ever closer to their free-living relations.



This vignette represents one of the Plymouth fishing boats denominated locally as "Hookers."

13

COPEPOD CRYPTOGRAPHY

To dire Lernaean *Hydra* what art thou?
Her wounds were fruitful; from each sever'd head
Each of her hundred necks two fiercer bred.

—Ovid, *Metamorphoses*

These animals approach near to worms and to insects, without belonging to either. They indicate the existence of a particular series, which may probably form a new class, and which may properly fill up the great void which exists between insects and worms. I only at present make a simple provisional indication.

—Lamarck, *Histoire Naturelle des Animaux sans Vertèbres*

THE DECADE after 1820 disclosed ample evidence for the placement of all the parasitic cryptic copepods with the free-living species, by then long removed from the insects and ranked with the other crustaceans. Yet the concept of integrating the parasitic forms, bound in inertia, was slow to be grasped. Linnaeus had included the parasitic copepods (generalized lernaeids) with mollusks and zoophytes, and other early workers, such as Lamarck, placed them first with annelids and then within a distinct class, the Epizoaria. We have seen that Bosc described them under the soft-mollusk worms, while at the same time suggesting that these bizarre forms might better be placed with the intestinal worms. Several influential publications, for example Cuvier's "Animal Kingdom" of 1817 and 1830, did just that. Oken again believed that they were mollusks and held them in a family close to the equally bewildering barnacles.

This chapter highlights several isolated descriptions of parasitic copepods that added to the growing knowledge of the forms but that did not, by themselves, have significant influence in terms of reclassification, with the inevitable exception of the initial account. The first solid indication of the true nature of the lernaeids (in the broad sense) came from Suriray. Suriray (1819), who followed Oken by referring to lernaeids as caligids and their allies, revealed that their eggs, attached to the abdomen in long filaments, hatched into young resembling those of *Cyclops*.

Jacques Simon Amand Suriray

28 July 1769–4 March 1846

In spite of his importance in the history of the study of copepods, little is known about Suriray. Much of this vacuum is due to Suriray himself. He was obviously not a recluse, but his mannerisms and choice of obscure publications ensured that he would be nearly forgotten. Suriray's (1819) discovery was quickly brought into the mainstream literature by de Blainville (1822a), but its revolutionary nature was somewhat glossed over and its significance was obscured by de Blainville's own peculiar and short-lived classification (see Chapter 14). Suriray's scientific standing in the provinces was precarious, and he needed to cultivate the favor of the leadership in Paris. Therefore, his independent judgment regarding the true relationship of lernaeids took some courage in light of the dominant opinions of these strong authorities.

The first thing one notices in attempting to recover Suriray's original work is that he published without first name or first initial, and generally misspelled as "Surriray" or even "Surrivay" (Suriray 1820). Agassiz (1854) listed four Suriray publications: one each on rotifers and the physiology of terrestrial worms, and two on copepods. The latter are Suriray (1819) and its abstract (1820) in a Belgian journal, listed as "Observations sur le foetus d'une espèce de Calige." The abstract was unambiguously headed "Crustacea," yet its far-reaching significance was not immediately apparent.

Through the kindness of the Muséum d'Histoire Naturelle at Le Havre, I was able to obtain some unique Suriray material. The municipal archives, in spite of numerous wars, still contain the marriage certificate from 1807 when Jacques Simon Amand Suriray married Marie Madeleine Fouache. Suriray was then a thirty-seven-year-old licensed medical practitioner. He was born in Calvados Department near Caen, south of the Seine. At the time of his marriage, Suriray was living in Le Havre, the celebrated town on the Seine's north shore where the river joins the Channel coast. He was the son of Major of Artillery Simon Suriray, who had died in Caen in 1806. The bride's father was also a deceased major of artillery. Both mothers were present. The bride, age twenty-one, was from Le Havre.

With no opposition being recorded, the two parties were united in marriage. There were seven signatures, in addition to those of the new husband and wife, attesting to the deed: a twenty-four-year-old Suriray brother, a twenty-two-year-old Fouache brother, a thirty-nine-year-old and a forty-year-old doctor of medicine (listed as friends of the husband from Le Havre), the mayor of Le Havre, one other Suriray, and one other Fouache.

Suriray was a founding member of the Havre Society of Diverse Studies in 1834. I would not be surprised to learn that he himself picked this name, from his own eclectic interests. It is from Suriray's obituary published by this society that most of his life details are known (Lecadre 1848). Curiously, Suriray's full name was not published even in the obituary; it is likely that the marriage record saved his full name from oblivion.

Suriray served as a physician in the Army of the Vendée. From there he practiced at Harcourt until asked to join Dr. Julien René Lechevrel (one of his friends from the marriage certificate) in Le Havre by 1807. He was successively a surgeon and the chief physician at Le Havre hospital, the regional physician of epidemics, and a member of the public health committee. Suriray found time in between for a wide variety of scientific pursuits, including the morphology of the human skull, mesmerism, and the circulation of sap in plants.

Among his good friends and correspondents were Péron and Lesueur, who will soon have their own places in this history. Suriray worked with both at Le Havre in 1808 and accompanied Lesueur on surveys of the area's seashores from 1812 to 1814, noting especially marine algae and fossils. From these excursions, and from the work on the Baudin Expedition medusae, Suriray was intrigued by bioluminescence. Lesueur kept a notebook describing these activities:

> I was for the most part of these excursions either alone or with Mr. Suriray, physician recommendable by his knowledge and the love which he carries for natural history and to which he dedicates all the moments that his profession permits; he observes with care all the animals that inhabit our shores and studies their ways and their habits.
>
> He carried his research even to the microscopic animals from seawater and to the phosphorescence with which these small creatures are endowed; he has addressed a memoir on this subject to the Institute complete with valuable facts for this branch of science—these small animals are in such numbers that they give to the surface of the water that luminous phosphorescence that shines with clarity as soon as one agitates the surface.
>
> Mr. Suriray has done this work by the invitation and inspiration of my [late] friend Péron, in a small voyage that we made around Havre, with which we have been occupied and whose results have led us to recognize that this phosphorescence is due mainly to the great quantity of phosphorescent animals of which the sea is supplied by innumerable legions, whose components during putrefaction tend to settle into the water once the gas that supports them at the surface has escaped.
>
> On a voyage on which I had the occasion to be with my friend Desmarest accompanied by Mr. le Dr. Suri-

> ray, we repeated our excursion that we had carried out as far as Bleville, Octeville, and Cauville, 4 leagues [16 km] from Havre. (Lesueur MS, 1814, Le Havre Museum)

Suriray submitted a progress report and a proposal to continue this work (Bosc, Lamarck, and Lacépède 1811). The review committee felt that Suriray should be encouraged but that more information was needed on the subject before it warranted extensive support. This may have materialized, because Suriray was heard from again in regard to marine phosphorescence:

> From 1810 M. Suriray had observed the phosphorescence in our seas to be exhibited with the same characters every year during the summer season, but it was interrupted in the waters of the channel when the cholera morbus prevailed at Havre and its vicinity in the months of May, June, and July 1834. Several naturalists of the French capital, who are in the habit of visiting our harbour [London] from season to season, and who had been observant of the phenomena, confirm this remarkable fact; and the whole city is witness to the sudden and very general mortality of the fishes kept in our preserves of brackish water which then occurred. All the eels and flat fishes came to the margins and died. M. Suriray examined with the microscope some drops of the water become a little putrid, and he ascertained that its slight blood-tinted colour depended on the increase of different kinds of infusory animalcules. The diffused phosphorescence observable in our seas during the summer, M. Suriray attributes to the prevalence of a minute species of medusa (*Noctiluca miliaris*), which he has described and figured in "Guerin's Magazin de Zoologie."[1]

Although Suriray gave this dinoflagellate the name *Noctiluca,* meaning "night light," in 1836, he was not the first to note that it is luminescent (see Slabber's account in Chapter 8). But Suriray's correlation of discolored seawater with "different kinds of infusory animalcules" and to seemingly unrelated phenomena like cholera epidemics, both of which coincided with fish kills on the other side of the English Channel, must have been one of the earliest such records suggesting extensive and convolutely linked ecological factors.

Cholera, an infectious bacterial disease, was known in India long before it was described as pandemic in Turkey and Persia from 1817 to 1823. Pandemic cholera was seen again, probably starting in Russia and spreading throughout Europe, from 1829 to 1851. Cholera has reemerged as a leading worldwide cause of misery and death. Only recently has it been revealed that there is a relationship between copepods and cholera. Copepods harbor cholera pathogens either as a substrate or as a symbiont, and the drinking of infected copepods, even a few, in contaminated water is a major source of the disease. There is also a strong correlation among weather, phytoplankton blooms, copepod (and other zooplankters) production, and the occurrence and spread of cholera. The pathogen can exist in a viable state for very long periods, months if not years, even in seawater (Caldwell 1996).

A few perceptive early physicians noted the correlation of the disease with contaminated water supplies. Early attention to sanitation, whether or not the mechanism was understood, had dramatic effects in lessening the spread of cholera. Cholera has more than once crossed this narrative's path. Tilesius published medical papers on Asiatic cholera, and we have noted that the deaths of Cuvier (in 1832) and Leach (in 1836) were ascribed to this feared disease. Do not be comforted by the detachment of the many decades since; these were not easy deaths. There are at least seven other instances where cholera impacted those who have studied copepods, although none ever imagined that there could be a copepod/cholera connection. Suriray's observations are mentioned here; cholera is encountered again in the stories of James DeKay, Constantine Rafinesque, and Anders Retzius. Michael Sars avoided a Berlin cholera epidemic in 1837. Five years earlier, Nordmann left Berlin for the same reason, taking up residence in Odessa. Odessa proved to be no cholera refuge; Nordmann's wife died there in an epidemic in 1848. Finally, American malacologist Augustus Addison Gould (1805–1866), who touched on copepods in his work, also died of cholera.

Baird (1850), that indefatigable chronicler of obscure early works on copepods, said of Suriray only that he was a French physician at Havre. Baird indicated Suriray's role in being the first to describe the newly hatched larvae of "caligids," but he gave no references. Like Wilson (1917b), Baird learned what he did of Suriray from de Blainville. The lernaean for which Suriray described the early development was given the name *Lernaeocera surriraiis* by de Blainville, using an incorrect spelling of Suriray's name; this is

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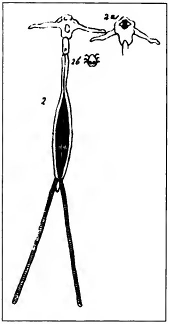
[1] *Magazine of Zoology and Botany* 1 (1837): 491–92.

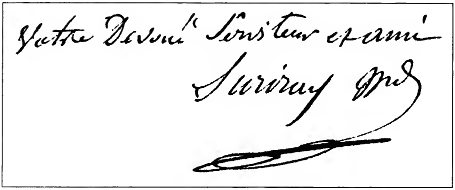


Lernaeocera surriraiis de Blainville, found by Suriray on the pectoral fin of a "small fish at Havre" and sent to de Blainville. Figure 2a is another view of the head; Figure 2b is the "fetus" just hatched from the egg, after a drawing by Suriray (de Blainville 1822a).

now an uncertain species in the genus *Lernaeenicus* (see Kabata 1979). Suriray (1819) said that he took the hatching eggs from many females that were fixed to the operculum of an *Esox belone* Linnaeus. This fish is now in the genus *Belone* Cuvier, 1816, the marine needlefishes. When de Blainville (1822a) recorded a personal communication from Suriray, publishing for the first time a drawing of the adult and nauplius stage of this copepod species, he said that Suriray's specimens were from two unidentified fish from Le Havre. Perhaps Suriray made his important observations from more than one fish species.

In 1835, Suriray "broke his bonds" and went to Paris (Lecadre 1848). From that time, he was a corresponding member of the Havre Society, signing himself "former physician." At an age when most people had achieved their careers, Suriray, at sixty-six, attended classes and consulted scholars and their collections. He traveled to the Pyrenees and the Swiss and Italian Alps to study firsthand the flora, thermal springs, and artistic monuments. Suriray had a lifelong interest in English scientists and their accomplishments; at seventy years of age he traveled through England to find the "secret" of its industry and its progress.

Suriray died in Paris in 1846. In one last obfuscation, the death certificate named him "Surivay." The Havre Society paid tribute to "the many merits of their honorable colleague, a scholar and a right-thinking man. Above all, a man of observation" (Lecadre 1848). Péron named a medusa from the English Channel *Aurelia suriray* in his honor. Later in the century, when Suriray was fading from living memory, Le Havre dedicated the "Rue Docteur Suriray" to him.



Votre Devoué Serviteur et ami
Suriray Md

Signature of "Votre Devoué Serviteur et ami, Suriray M.D." From letter to Péron, 30 July 1809; Letter 68491, Museum of Natural History, Le Havre.

August Friedrich Schweigger

8 September 1783–28 June 1821

August Friedrich Schweigger was obliged to account for the lernaeids in his "Handbook of Natural History of Unsegmented Invertebrates," published in 1820. He speculated on their place in the natural world in a section titled "On some so-called worms which are found attached to other animals":

> The position of the lernaeids, which live attached upon the gills of fish, is uncertain. Oken considered them under the Entozoa, although within their own family, in one of three genera. So do now Lamarck and Cuvier.—One distinguishes in these animals nothing but an intestine and an egg-mass. The reason they have been placed with Entozoa is that they are zoophytes, and they live parasitically upon other animals. Besides that, they are to some extent related to nematodes, in part by their appearance, in part by their intestine and egg-mass which is clearly of the [same] form.
>
> Lamarck anchored *Lernaea* with the genus *Chondracanthus*,[2] which Cuvier placed last next to the caligids in the Class Crustacea. I have frequently observed *Chondracanthus thynni* at Nice, yet I can perceive neither respiratory organs nor vascular system. Cuvier based his decision on the following grounds:
>
> 1. All Entozoa, *Philline* [a helminth], *Lernaea* et al. have no articulation, while on the contrary in *Chondracanthus* the single pieces are joined up with an articulation. Therefore, the [former] animals remove themselves from the crustaceans.
>
> 2. The outer cuticle of *Chondracanthus* is brittle, resembling the shell of Entomostraca with regard to the substance.
>
> 3. Other than lernaeids, most of the species, especially *Chondracanthus zei*,[3] look like crustaceans.
>
> To me it appears most natural to leave *Lernaea*, *Chondracanthus*, caligids and similar genera undivided, and certainly in the Class Crustacea. Lernaeids have only

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[2] Footnote in original: "Cuvier le règne animal 4, pl. 15, fig. 5."

[3] Footnote in original: "Nouv. Bull. de la Soc. Phil. 1811, p. 270, fig. c."

> little similarity to Entozoa. That the mouth of several species have arms on the side takes out the genus *Chondracanthus,* which is then placed firmly with the crustaceans. The separation of the lernaeids appears to me just as unnatural, as when one would remove *Cypris, Daphnia, Polyphemus* and similar genera from the family Entomostraca, because their organization is simpler than that of the remaining crustaceans. Every class has a species which is a reference point with respect to lower-standing classes. Many examples of these forms were presented in the general characteristics of the animal classes, and this appears also to be the case with lernaeids. The association of lernaeids with entozoans stands moreover to the contrary, [in] that the construction of the former appears more complex. Their arms are provided with absorbing vesicles and they can, as a cuttlefish [*Sepia*], hold themselves fast by these without using the mouth: a construction that, however, is not found in the entozoans, and is characteristic chiefly in animals of the upper classes. (Schweigger 1820)

August Friedrich Schweigger (1783–1821). Courtesy of the National Library of Medicine; signature courtesy of Kraig Adler.

So, Schweigger was right on the mark and his argument was fairly good for the material at hand. Note that he even observed *Chondracanthus* on the Mediterranean coast. Unfortunately, his argument seems to have been lost in the face of stronger personalities; his early death may have aided the neglect. The only reference I have seen of Schweigger (1820) was in Retzius (1830), and even Retzius, at the end of the decade, seemed not to believe that the "lernaeids" were crustaceans. To make matters worse, Schweigger, who was highlighting *unsegmented* forms and therefore did not have a classification for crustaceans, still held lernaeids as nematode-affinity Entozoa in his Latin summary tables. In common with the period, Schweigger also defined crustaceans as having no metamorphoses and mentioned in particular *Cyclops* and *Dichelesthium.* With such conflicts it is not surprising that few then believed lernaeids could be crustaceans. Even though he said that it was not likely, Schweigger showed the lernaeids as equivalent to Lamarck's Epizoaria *including Chondracanthus.* He listed three species of *Lernaea,* with references to Linnaeus and Müller.

The title page for Schweigger (1820) records that he was a Doctor of Medicine and an Ordinary Professor of Medicine and Botany at the University of Königsberg in East Prussia. Schweigger also indicated that he was the Director of the Botanical Gardens at Königsberg and a member of several naturalist societies throughout Europe. Agassiz (1854) listed four publications in addition to the invertebrate handbook: one each on sea turtles and corals, and two general works. Schweigger wrote of the difficulties working on his book, each subject requiring a separate trip to Berlin of "90 German miles" (414 English miles). He noted that Berlin was the nearest location of significant collections and library.

The titles of Ordinary Professor and Extraordinary Professor arise often in the history of the study of copepods. While these titles appear to have been (as they still are) earned degrees in, for example, Poland, in nineteenth-century western Europe they were specific appointments to a university faculty, reflecting a status much like tenure/nontenure in recent years in American universities:

> The title of Professor was given to teachers in the universities of the Middle Ages, whenever they also, preferably, were named *doctores* or *magistri,* and it continues now as the regular designation of the university teachers. These are divided into the Ordinary Profes-

> sors, with definite privileges provided by the college, and Extraordinary Professors. The teachers at the highschools of similar standing to universities (technical highschools, schools of mining, forestry academies, etc.) likewise bear the title of Professor, and in some states also the teachers at gymnasiums, while in Prussia up until now this only had been bestowed as a mark of respect in individual cases, but now it is evidently bestowed upon all senior teachers. In a similar manner the title was also bestowed to other scholars and artists. (Brockhaus 1895)

In spite of his relatively short life, Schweigger was a widely known botanist. He was born in Erlangen, near Nuremberg.[4] Schweigger's family had many respected scholars, including his brother Johann Salomo Christoph Schweigger (1779–1857), who was a physicist at Halle. Schweigger received an excellent education starting in his home, then at the gymnasium in Erlangen, and then, in the autumn of 1800, at the University of Erlangen (founded in 1743). Schweigger aimed for a scientific profession, taking courses in medicine, zoology, and botany. He became a special student of the naturalist Johan Christian Daniel Schreber (1739–1810) (another of Linnaeus's pupils) and thereafter emphasized botanical studies. In late 1804, Schweigger obtained an M.D. with a thesis on the flora of the Erlangen region (Wunschmann 1891b).

Berlin then beckoned to Schweigger, offering courses in practical medicine. There he was befriended by a government minister who provided a scientific trip to Paris. During this sojourn, Schweigger was often together with other Prussians, a number of whom were politically dissatisfied. Although the news of the battle of Jena (14 October 1806, Napoleon's victory over Prussia and Saxony) deeply troubled his patriotic feelings, Schweigger remained in Paris. He was untiringly active in the Museum of Natural History and its collections. He was encouraged through the support of French savants, especially the botanist Antoine de Jussieu and the mineralogist Haüy. Schweigger also became a close friend of the Munich academician Johan Baptist von Spix (1781–1826) (who in 1817–1820 explored the botany of Brazil). Schweigger's zoological work was begun in Paris with a monograph on sea turtles, followed by anatomical/physiological investigations of corals.

Altogether, Schweigger lived in Paris more than three years, leaving in 1809. He was soon called to Königsberg as Professor of Botany. Through his correlative work as director of the Königsberg Botanical Garden, Schweigger added to his flora of Erlangen in 1811 and published other papers on mountain flora and plant classification. His main contributions to botany were in applying concepts from comparative anatomy (zoology) to plant systematics.

Schweigger took every opportunity to improve by way of travel his scientific teaching activities. He was recorded in Stockholm as meeting with members of the Swedish Academy of Sciences (Lindroth 1967b). An excursion to Sicily in the summer of 1821 ended with his covetous guide/coach-driver killing Schweigger in the "Fuming Grotto" at Cammarata (mountain in west-central Sicily), near Girgenti. Schweigger was not yet thirty-eight years old (Wunschmann 1891b). This explains the intriguing and certainly true comment by Nordmann (1832) about "the unfortunate Prof. Schweigger" who made many contributions to the study of invertebrates. Schweigger is included in our select group of early copepodologists because of his insights on the relationships of the parasitic forms.

Georg August Goldfuss

18 April 1782–2 October 1848

Like Schweigger, Georg August Goldfuss joined the copepod congeries when he accounted for lernaeids in a general zoology text. He seemed also to have a parallel instinct as to their true relationships to crustaceans. And, like Schweigger's, Goldfuss's revelation went unheeded by those who were in greatest need of direction: the copepodologists themselves.

Goldfuss and Schweigger had other comparable elements besides their thoughts on lernaeids. Goldfuss was also a Bavarian, born in Thurnau near Bayreuth. A student at the University of Erlangen in 1805, he began a dissertation on the beetles of South Africa. He became close to the botanist and natural philosopher Christian Gottfried Nees von Esenbeck (1776–1858), who was to be his colleague for twelve years at Bonn. Together they followed the principles of the then popular natural philosophy, although without Oken's severity.

After completing his studies in 1810, Goldfuss became a tutor in a baron's family near Erlangen. He also studied at the University of Erlangen and qualified for his Privatdocent there in 1812 (Carus 1879b).

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[4] Erlangen is another town of complex history. At the time of Schweigger's birth, it was administered by the margraves of Bayreuth, passing to Prussian control in 1791, and to Bavaria in 1810.

Goldfuss was called to the University of Bonn in 1818, as Professor of Geology and Zoology. His most famous pupil, from 1819 to 1823, was undoubtedly Johannes Müller (Koller 1958).

Goldfuss enhanced his reputation through energetic discoveries made in caves in the vicinity of his home. In 1810, he published a description of a cave in the Muggendorf area; he followed this in 1816 as the coauthor of a general physical description of the region. A turning point came with the acquaintance of the eminent paleontologist Count Georg zu Münster (1776–1844). After 1818, Goldfuss published several descriptions of fossil cave-dwelling mammals and reptiles in the proceedings of the venerable Academiae Caesareae Leopoldino-Carolinae Naturae Curiosorum. From 1826 to 1833, Goldfuss applied himself to his greatest work, a series on the fossils of Germany, with zu Münster as collaborator.

The relationships among animal classes rest on several points, and Goldfuss sought to present these in the manner of natural philosophy, using the developmental stages of the animal kingdom. He illustrated with a cross to represent the whole of his four-way classification of the natural world's components, now seen to be mostly a fantasy. Goldfuss did attain lasting fame along these lines, however, when he used a similar treatment in a classification of zoophytes in 1818. In that paper he introduced and defined the term "protozoa," understood as a matter of course by all biologists today, although his classification included a few polyps and medusae (Cole 1926).

Ironically, I was first drawn to Goldfuss as well as to Schweigger by references in Retzius (1830). Even though Retzius apparently dismissed their notions about lernaeid relationships, he was ambivalent enough about them to cite their interesting origins. Goldfuss published a two-volume *Handbuch der Zoologie* in Nuremberg in 1820 (the same year as Schweigger's book; the 1826 date given by Retzius is an error, although there was a second edition in 1834–1836). In this general text, Goldfuss stated that *Lernaea* was similar to *Chondracanthus, Caligus, Argulus,* and the king-crab *Limulus,* and he placed them all in the family Aspidota of a group that he called Polymeria. This perceptive joining of lernaeids with caligids and chondracanthids was likely overlooked in Goldfuss's obsolete and clumsy combination of crustaceans with arachnids.

William Scoresby (1789–1857). From Pilleri and Arvy (1981).

The parallels between Goldfuss and Schweigger led me to wonder if the two men compared notes. Goldfuss apparently came to Erlangen a year after Schweigger left, and it is doubtful if the copepod problem would have been on either mind at that time. I note no other possible personal connections, but they may have encountered each other in Berlin or elsewhere as both were preparing their general texts. Agassiz (1853) recorded twenty-two geological and zoological works by Goldfuss, between 1805 and 1841.

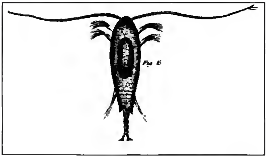
William Scoresby

5 October 1789–21 March 1857

William Scoresby is a minor entry with regard to copepods, but his exceptional observations of living forms seen only by few excited those who heard him or read his splendid accounts. In this, Scoresby certainly had uncommon influence (Tait 1968, Ritchie 1972).

Scoresby was born near the North Sea town of Whitby, in Yorkshire, northern England. His father, also a William, was a whaler. Young William joined his father at sea at the age of ten for the first of approximately twenty Arctic whaling seasons. Father and son reached 81°30' North latitude in 1806, the most northerly point attained by a free ship to that time. By 1811, young William was in command of his father's ship (Pilleri and Arvy 1981).

During the winter between Arctic forays, young William studied in Edinburgh. His ability as a student, his observational skills, and his unparalleled experiences soon caught the attention of natural history professor Robert Jameson (1774–1854). Scoresby was a Jameson student in 1806 and 1809 (Tait 1968). Jameson held his important professor's position for exactly fifty years. During his long tenure, he had many students who were eventually famous; we will encounter in particular Edward Forbes, Charles Darwin, and Wyville Thomson. Most nineteenth-century expeditions of the British Navy, such as the Franklin Expedition and the *Beagle, Rattlesnake,* and *Challenger,* included naturalists who had studied at the University of Edinburgh under Jameson. Scoresby can be credited for some of this influence as well. Jameson recognized that Scoresby had learned by experience far more about whales and the natural history of northern seas than most anyone of their time. On these subjects, it was very much a case of the pupil teaching the professor. Jameson encouraged Scoresby to enthuse the other students and to record his facts. This led to several interesting papers and a natural history classic, Scoresby's (1820) two-volume *An Account of the Arctic Regions,* dedicated to Jameson. The primary zoological material on whales was translated by de Blainville and incorporated into his work on cetaceans.



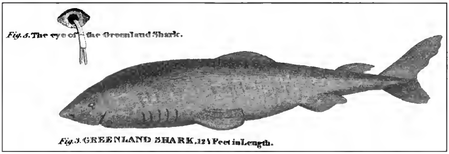


Fig. 5. The eye of the Greenland Shark.
Fig. 3. GREENLAND SHARK, 12½ Feet in Length.

Included among the "animals, constituting the principal food of the whales" was this "beautiful little animal," probably a* Calanus *sp. (from Scoresby 1820, Pl. 16, fig. 15). "The eye of the Shark, on a larger scale, showing the form of a curious appendage that is generally found attached to the pupil." From Scoresby (1820), Pl. 15, fig. 5.

It was Scoresby's Arctic account that brought him briefly onto our stage. Although Scoresby was no copepod taxonomist, his revelation of the great whales filter-feeding on "water-insects" has long thrilled many stay-at-home copepodologists (Marshall and Orr 1955). Scoresby offered a figure of one of these "insects" (a calanoid) captured in his "marine diver," a self-closing brass water-sampler that he also described and figured—the marine diver was fourteen inches long, five inches in diameter at the top and six inches at the bottom, and weighed twenty-three pounds. Scoresby's calanoid was

> a beautiful creature that was brought up by the marine-diver, in the Spitzbergen Sea. Its length, excluding the antennae, which were as long as the body, was one-tenth of an inch in one specimen, and one-fourth of an inch in another. Its body was beautifully transparent, and had quite a crystalline appearance. The antennae were red. In swimming, it proceeded by starts, and appeared very active.
>
> The economy of these little creatures, as constituting the foundation of the subsistence of the largest animals in creation, has already been noticed. (Scoresby 1820)

Scoresby found several specimens of a lernaeid fastened to the eye of a Greenland shark. He sent two large specimens, preserved in spirits with the joined eyeballs, to Sir David Brewster (1781–1863) of the *Edinburgh Journal of Science,* who passed them to "Dr. Grant" who described them as a new species in 1827 (see below). Scoresby described this "singular appendage to the eye." He said that "the sailors imagine this shark [with the eye parasite] is blind, because it pays not the least attention to the presence of man" (Grant 1827, Baird 1850).

In a chapter on the zoology of the Arctic, Scoresby (1820) gave a "brief account of Amphibia [sharks], animalcules, &c. inhabiting the Spitzbergen Sea." In the Class Vermes, he recorded "*Lernaea branchialis*—found by Captain Phipps in the gills of the *Cyclopterus liparis.*" This host was "the unctuous sucker" (an "Amphibian"), from "northward of Spitzbergen."

While away on his last northern voyage in 1822, to Greenland, Scoresby's wife died. When he returned, he committed himself to theological studies at Cambridge, obtaining a D.D. He was was ordained in 1834 and made vicar of the Liverpool Sailors' Church. Late in life, he designed compasses according to his own research on magnetic fields. This led him on a voyage to Australia, with the resulting journal published two years after his death at Torquay, on England's south coast (Pilleri and Arvy 1981).

The Reverend William Scoresby was admitted by those respectful of science and letters to be a Fellow of the Royal Societies of London and Edinburgh and a member of the Institute of France (Ritchie 1972). On his gravestone, at the Torquay Parish Church, are four carvings: a cross for his faith, an anchor for his seamanship, a compass for his research, and, of course, a whale (Pilleri and Arvy 1981).

Adelbert von Chamisso

ca. 27 January 1781–21 August 1838

We now look at circumstances reminiscent of those that led to Tilesius's copepod contribution. On Krusenstern's 1803–1806 world-circling expedition, along with Tilesius, there was a young naval officer of heroic potential: Otto von Kotzebue (1787–1846). Kotzebue commanded his own Russian scientific circumnavigation in 1815–1818, the first of two, in an attempt to cross the Arctic Ocean via the Northeast Passage. One of the naturalists on board Kotzebue's ship *Rurik* was the refugee-soldier-botanist Adelbert von Chamisso, who is admitted into our company by the single mention of a pennellid copepod and a flash of insight. Chamisso very nearly carried out the copepod coup d'état of the century. Not that he needed any exceptional recognition from us; his later life would leave him admired by other scientists, as well as artists, linguists, musicians, poets, and men of letters. This proves, I suppose, that there is life after copepods, but Chamisso could have been an artist/poet with copepods as well, if he had chosen.

Chamisso was born Louis Charles Adélaïde de Chamisso de Boncourt in Champagne, France. With such a name, of course, he was a hunted man during the Revolution; his family fled The Terror, going first to Holland and then through Germany, stopping in Berlin in 1795. Chamisso the youthful aristocrat found employment as an artist in a porcelain factory. Soon, however, he followed his forebears into the army, except that now he was on the other side, with Prussia, where he served as a cadet and an officer from 1798 until 1807 (Feudel 1971, Kratz 1986).

Toward the end of the Napoleonic Wars, Chamisso and two brothers returned to France, but our subject, now Adelbert von Chamisso, after a short visit and a sojourn in Switzerland decided to return to Germany. In 1813 he enrolled at the new University of Berlin to study natural history, but his studies were interrupted by war. In 1815, as war threats stirred again, Chamisso decided to leave Europe altogether and accepted the botanist's post on the *Rurik* (Kratz 1986).

The bark *Rurik* was built in Finland especially for this expedition. Lt. Kotzebue's entourage included an entomologist, an artist, and a "doctor," one Johann Friedrich Eschscholtz (1793–1831), who was also an all-around naturalist. Of Eschscholtz, Chamisso said

> I always studied, observed, and collected together with my faithful Eschscholtz. In complete harmony, we never distinguished between mine and thine. One of us would take pleasure in his own discovery only when he had called the other in as witness, as participant. (Chamisso, qtd. in Kratz 1986)

Chamisso called Eschscholtz his "closest friend" and described and named for him *Eschscholtzia californica,* the beloved California poppy.

The ship left Kronstadt in July 1815 and stopped at Copenhagen to pick up the expedition's botanist, Chamisso. The expedition remains a remarkable human achievement, noted for the many North Pacific islands and inlets discovered and for the large and varied samples of natural resources and native crafts collected (Pilleri and Arvy 1981).

On its return, the *Rurik* stopped in Plymouth, England, and Chamisso met with Banks, Otto, and Cuvier in London (du Bois-Reymond 1889, Feudel 1971, Kratz 1986). Chamisso had several reasons to recall Plymouth:

> Since then I have seen nowhere else a shore so rich in seaweed and seaworms. I recognized hardly any of these animals. I couldn't find them in my books and I was appalled at my ignorance. I did not learn until later that the most of them remain unknown and undescribed. In the course of the voyage I missed a lot in this way, and I am dutifully noting it here as a lesson for my successors. Observe, my friends, collect and store away for science everything you can get your hands on, and don't be led astray by the idea that this or that must be known, and you just don't know about it. (Chamisso, qtd. in Kratz 1986)

But Chamisso was not an indiscriminate naturalist-looter, as revealed in this recollection from the Philippines:

Mr A. de Chamisso.
Naturaliste de la Première Expédition de
Otto Kotzebue dans le Voyage autour d

(left) ***Adelbert von Chamisso (1781–1838) on Kotzebue's Expedition. From Feudel (1971).***

(right) ***Adelbert von Chamisso, recently returned from Kotzebue's Expedition, wearing what appears to be a Siberian native artifact. From Feudel (1971).***

> A large tortoise had taken up quarters in [an elderly French émigré's] yard and garden; honeysuckers (*Nectarinia*) nested in a branch of a tree that almost extended into the window of his room; and every time we drank coffee a small gecko (a house lizard) appeared on the table to lick the sugar. He offered me these various animals. But how could I have laid hands on these companions and guests of this man who was already so deprived of friends and relatives? To do this I would have to be a different person than I am. (Chamisso, qtd. in Kratz 1986)

Chamisso returned to Germany in 1818 with an impressive gathering of animals and, especially, plants for the Berlin Museum. He was appointed curator of the botanical gardens in Berlin, a position he held for thirteen years. Chamisso married in 1819 and, that same year, received an honorary doctorate of philosophy from the University of Berlin and became a member in the Society of Friends of Natural History (Mahly 1876, Feudel 1971). In spite of a growing dedication to a literary calling, Chamisso found time to complete several important natural history studies, mostly based on his experiences on the *Rurik*: on coral islands, on Aleutian natives and cetaceans, on salps (he was the first to point out alternation of generations, in this case in pelagic tunicates), on terrestrial mollusks of Hawaii, and on Philippine volcanoes (Agassiz 1850, du Bois-Reymond 1889). Chamisso published a compendium of useful and injurious plants from north Germany and many botanical contributions from the Kotzebue Expedition. In 1835, Humboldt's nomination made Chamisso a member of the Berlin Academy of Science.

Chamisso's claim to copepod fame is based on one paper (Chamisso and Eysenhardt 1821), the first to be noted here that is explicitly coauthored. Of Carl William Eysenhardt (1794–1825), I have learned little; Agassiz (1850) listed seven papers on a variety of zoological subjects. Harvard University Library listed his life-span dates and cataloged eight papers, mostly on algae. Apparently a doctoral thesis dealt with the microscopic structure of the kidney. Eysenhardt's short life undoubtedly denied his potential. Perhaps his greatest stature rests now on his brush with Chamisso.

Chamisso and Eysenhardt (1821) described many "worms" collected on the Kotzebue Expedition, often, as in the case of the copepod, by "our most-friendly companion, that sharp-eyed observer of nature, Eschscholtz." The copepod was classified under the Annulata Apoda—that is, with the leeches. It was identified as *Pennella diodontis,* believed to be the same species as that from the La Pérouse Expedition and Holten's *Lernaea exocoeti.* The authors added that *Pennatula* Linnaeus, "which is the same

(left) ***Adelbert von Chamisso at the time of his marriage in 1819. From Feudel (1971).***

(right) ***Adelbert von Chamisso. From Pilleri and Arvy (1981).***

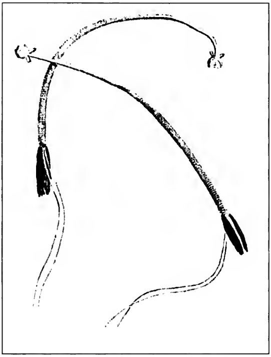
as Boccone's species," is related, a fact already pointed out by Oken when he substituted the genus name *Pennella.* At Kamchatka, Chamisso found a copy of Bosc's "Worms" and other useful books, which he borrowed on the condition "sacredly observed" that he return them to the Academy of Sciences at St. Petersburg (Kratz 1986).

Chamisso made two small but good drawings, dorsal and ventral. (Those reproduced here are from an old pre-xerographic copy and do not do justice to the originals.) Regarding this puzzling animal, the authors made a bold statement, but unfortunately they did not give their reasons nor did they stress it: "the supreme Cuvier placed lernaeids with intestinal worms; however, in our opinion our animal is contained among the Crustacea. [Nonetheless,] we have placed the figured specimen among the Annulata, in agreement with the perceptive Eschscholtz, who found it on the gills of a *Diodontis molae* caught in the North Pacific Ocean" (Chamisso and Eysenhardt 1821). This is an amazing conjecture, especially in the face of "the supreme Cuvier"; they had grazed a great truth.

This valuable paper described many animals other than worms: echinoderms, medusae (including new species of the ctenophore genus *Beroe* Bosc and the siphonophore genera *Velella* Bosc and *Porpita* Bosc), hydroids, and infusoria (a new species of *Paramecium* Müller). It was novel, too, to see lists of the species that had been deposited (both dry and in spirits) in the Berlin Museum; the copepod was not among them.

Of connections, there is no end: the young Alexander von Nordmann, a copepodological star of the next decade, came under Chamisso's wing in the late 1820s. An early interest in natural history brought Nordmann to the University of Berlin. He and Chamisso became good friends, nurtured by Nordmann's acquired interest in helminths and other parasitic worms, and they shared an expedition to Helgoland in 1830 (Puzanov 1969). Perhaps discussions of Chamisso's puzzling pennellid led Nordmann to add copepods to his growing zoological repertoire.

Relatively few persons renowned for copepod research will be found in a standard encyclopedia, but Chamisso, through his prominence in other fields, earned such worldwide general respect that he has a place there. The botanical and zoological achievements (du Bois-Reymond 1889) usually mentioned are overwhelmed by Chamisso's work in liter-



Pennella diodontis. *From Chamisso and Eysenhardt (1821).*

ary fields. His poems, ballads, and romantic novels comprise several volumes. As a poet, Chamisso is numbered among the best and most imitated of Germany (Feudel 1971). He met the young Danish poet Hans Christian Andersen (1805–1875) and was the first to translate his works into German. Chamisso is remembered for his pure-hearted and romantic character, his earnest manner, and his genuine morality. Some Chamisso novels are well known, but I have been attracted most to "The Fantastic Story of Peter Schlemihl." In 1813, to amuse the children of a friend, Chamisso invented Peter as a luckless character who sold his shadow to the devil for an ever-full purse of gold. From Peter's adventures, widely translated, the Western world retained a synonym for a bumbling ill-fated fool: a schlemiel. A famous English version of *Peter Schlemihl* was illustrated by George Cruikshank.

In a remembrance from his *Rurik* years, Chamisso shared part of his life's philosophy:

> [A friend in London] helped me to collect everything belatedly that I had been lacking on the voyage in the way of instruments, books, charts, in order for me to equip myself for the trip home with everything I should have had on the trip out. Would anyone who is smiling at this have been any smarter about it? For my part, for every new chapter of my life that I simply live through as well as I can, I am modestly prepared for the fact that it will not bring me the wisdom I needed at the beginning until it is over, and that on my deathbed I will find the missing wisdom of my life. And I have no regrets, because I have not failed knowingly and on purpose, and because I am of the opinion that other people do not do much better than I have done. (Chamisso, qtd. in Kratz 1986)

"French by birth and country, but more German by nature and character" (Mahly 1876), Chamisso spent his last years editing and writing romantic verse and musical themes. He also compiled a lexicon of the Hawaiian language, a memento of his voyage of discovery around the world. Robert Schumann composed music for one of Chamisso's best-known lyrical works. Even though Chamisso was tangled and tossed in revolutions and warfare throughout his life of fifty-seven years, his transcending accomplishments endure and inspire:

Im Schmerze wird die neue Zeit geboren;
Sie wird nach Männern, so wie du, begehren.

[The new epochs are born in suffering;
They come from all men's longings, as much as yours.]

—CHAMISSO, QTD. IN DU BOIS-REYMOND (1889)

James Ellsworth DeKay

12 October 1792–21 November 1851

Although James Ellsworth DeKay (sometimes as De Kay) came from a strong maritime family, he chose medicine, writing, and zoology as his principal pursuits. His ability to adapt to foreign settings was no doubt inherited from his international family. DeKay's father was an American sea captain, living in Lisbon, Portugal. DeKay's mother was Irish. DeKay was born in Lisbon, but in 1794 the family returned to New York, where DeKay was orphaned by the age of fourteen. I have found most of the following biographical information in Wilson and Fiske (1888), Johnson and Malone (1930), and Welch (1996).

DeKay obtained formal schooling in New York City, even then revealing interests as an observer of nature. By 1811 he had switched to medical studies in Connecticut, but zoology attracted him more, as it

James Ellsworth DeKay (1792–1851). From Fairchild (1887).

always would. DeKay had a parallel interest in literary skills and formed lifelong attachments in those circles. He became close friends of the poets Joseph Rodman Drake (1795–1820), Fitz-Greene Halleck (1790–1867), and William Cullen Bryant (1794–1878), and the novelist James Fenimore Cooper (1784–1851). DeKay wrote about American art under the pseudonym "Joe Strickland."

In 1818, DeKay was a medical student at the University of Edinburgh and received an M.D. in 1819 with a thesis on uncertainties in physiological experiments. His return to America brought him into the New York Lyceum of Natural History, established in 1817 by Samuel Latham Mitchill (1764–1831) and others (Fairchild 1887).[5]

The Lyceum of Natural History was founded 24 February 1817 (chartered 20 April 1818), making it the fourth oldest scientific society in America, after the American Philosophical Society of Philadelphia (1769), the American Academy of Arts and Sciences of Boston (1780), and the Academy of Natural Sciences of Philadelphia (1812). The Lyceum was renamed the New York Academy of Sciences in 1876. Of our copepod coterie, only Rafinesque was an original member (as a corresponding member). DeKay missed that distinction by about two years. The society's historian recalled that DeKay

> was a short, square-built, dark-complexioned man, of grave aspect, but very courteous in manner. He entered the Society in 1819, and the early volumes of the Annals are enriched with several valuable papers from his pen. Soon after 1836 he was appointed zoologist in connection with the New York State Survey upon Geology and Natural History of the State. Four quarto volumes, beautifully illustrated, embody the results of DeKay's labor. Most of the work upon these volumes was performed in an upper room of the Lyceum building, which he occupied until the building was sold. After the completion of the work he removed to Oyster Bay, Long Island. . . . (Fairchild 1887)

DeKay was among the dozen or so most active members of the Lyceum, and he remained so for the rest of his life. He held several important positions within the society: corresponding secretary (1821–1823), vice-president (1824, 1827–1832, 1838), librarian (1825, 1828–1832), and recording secretary (1833). After the first year, there had been a custom of naming an orator for an anniversary address, and the speaker for 1826 was DeKay. "James E. DeKay was the first editor of the Annals, and to him is largely due the reputation which the first two volumes at once gave the Lyceum at home and abroad. . . . Much of the early growth and firm establishment of the library are due to his ability, labor and generosity." By the end of 1826, DeKay reported that as many books had been added to the library the past year as in the seven preceding years altogether. Most of these books were purchased through a windfall of money solicited by DeKay from a defunct military society. DeKay retired as librarian in 1832, but in 1835 donated "249 books and 17 pamphlets" (Fairchild 1887).

The Lyceum's collection of scientific books became well known. By mid-century, these were kept at the American Museum of Natural History, but they are now incorporated into the library of Columbia University. DeKay also worked to build a respectable museum:

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[5] Goode (1901c) called Mitchill "the Nestor of American science." Mitchill was an especially important ichthyologist, as well as a U.S. Congressman and Senator (Thompson 1918). Like DeKay, Mitchill had received his M.D. at the University of Edinburgh (in 1786).

LITH. OF ENDICOTT
NEW YORK
THE LOCUSTS; RESIDENCE OF J.E.DE KAY M.D.
QUEENS CO L.I.

DeKay's house, "The Locusts," on Oyster Bay, Long Island (from Thompson 1918). This old landmark burned down in 1931, together with the original portrait of DeKay (pers. comm., Eckford J. de Kay, November 1997).

> The *Lyceum of Natural History* in this city, was in its origin a private association of young men, who held occasional meetings. . . . Incorporated by an act of the Legislature in 1818, . . . it has from that period been steadily though silently, increasing in usefulness and respectability. An extensive cabinet has been formed, . . . and must ere long be a place for reference to all who wish to investigate these obscure classes of animals. . . .
>
> Every effort has been made to procure a suitable library, but from the expensive nature of the books required, with very limited success. It now contains about six hundred volumes. . . . In connexion with [a] plan of elucidating the natural productions of our country, the Lyceum has commenced the publication of its transactions, of which the second volume is now in press, and will shortly appear. . . . The flattering reception it has met with from the naturalists of Europe has amply repaid for the labor and expense of publication. (DeKay 1826)

DeKay had a nearly evolutionary point of view, promoting a "chain of being" and affinities between organisms in connected series. He correctly predicted that this was "the great problem," which indeed became the theme for systematic biology after Darwin:

> It is but natural to expect that more attention should be given to the examination of new species, than to a rigid criticism of genera. A knowledge of the former is doubtless of great importance, but the latter will enable us to detect the delicate affinities by which the different classes of organized beings are approximated, if not brought into absolute contact. We are aware that the idea of a chain of beings has been ridiculed as a philosophical reverie, but the more this question is examined with the light afforded by modern observation, the firmer will this opinion be established. Already we hear the terms, "natural series," "annectant groups," "regular series," and other expressions which mark the first glimmerings of light on this hitherto obscure subject. And when we reflect that these affinities have been for the most part drawn from external and obvious characters, that we have yet much to learn from the internal anatomy, that new species are continually discovered which connect hitherto separate genera, and finally, that every day brings with it the discovery of some extinct animal, whose structure varies more or less from those of any living being, we are insensibly led to admit that the idea of a chain of beings is neither visionary nor unphilosophical.
>
> Unremitting efforts are made by modern naturalists to distribute the animal kingdom into groups or fami-

> lies, allied by adventitious, and often highly artificial characters, derived from form or habit. Although the minuteness into which these researches lead will elicit the discovery of many curious analogies, and open a wide field for ingenious speculations, yet they will not in themselves contribute towards the solution of the great problem of a connected series of beings. In some instances we may observe that the external form undergoes rapid and scarcely connected changes, while the order and relative importance of the several functions is but slightly varied. In others, the functions are observed to undergo gradual but ultimately important mutations, while the form remains comparatively unchanged. Hence it is to comparative-anatomy, and its companion physiology, that we must look for the most important improvements and discoveries in zoological science. The great chain of being lies at present in an apparently confused heap; so that links which may possibly be far apart, seem to our partial and imperfect view, intimately connected if not in immediate contact. (DeKay 1826)

DeKay made an interesting comparison of the numbers of scientific books in libraries in the major U.S. population centers:

> A ready access to the records of science renders it an easy task to separate the known from the unknown, to ascertain when we have opened a new path in science, or whether we are merely pursuing the beaten track, and enables us to compare our own observations with those of our predecessors. The want of proper books to facilitate inquiries of a scientific nature has been long felt in this city; indeed it has frequently been asserted that New-York, in proportion to its population, contains fewer works in its public libraries than any other city in Europe or America. With a view of ascertaining the truth of this assertion, at least as far as our own country is concerned, we have taken some pains to procure the following comparative statement. . . . *New-York,* with a population of 170,000, possesses . . . 44,000 volumes; *Baltimore,* with a population of 70,000, has . . . 30,000 volumes; *Philadelphia,* with a population of 100,000, possesses . . . 70,000 volumes; *Boston,* with a population of 60,000, possesses . . . 55,000 volumes. (DeKay 1826)

DeKay left the mathematics to his readers and did not indicate that his list conformed to an improving situation. New York, with one book for every four persons, was in an unenviable position, especially when contrasted to Philadelphia or Boston, with about one book per person.

In 1821, DeKay married a daughter of Henry Eckford (1775–1832), naval architect and pioneer builder of steamships. (Another Eckford daughter was the widow of the poet Joseph Rodman Drake.) Eckford owned the *National Advocate,* a New York political newspaper, and proposed that DeKay become its editor, but this did not occur. Another unrealized DeKay literary connection was a possible joint magazine with Halleck as editor.

Eckford suffered serious financial losses over the following decade, and in 1831 he accepted a commission from the Sultan of Turkey to supervise the Turkish Naval Yard. Eckford built a corvette for the sultan and, together with DeKay and DeKay's brother George as commander, sailed to Constantinople in June.[6]

James DeKay returned to New York in March 1832. Unfortunately, Eckford died in Turkey later that year, and the family returned to America. DeKay published *Sketches of Turkey by an American* in 1833, mentioned by his friend Thompson:

> At the Cove, east of the village, in a romantic spot called the *Locusts,* partially shaded with trees of various kinds, and having a beautiful prospect of the surrounding scenery of land and water, is the residence of Dr. James E. Dekay, one of the geological commissioners of the state, to whom was assigned the zoölogical department, the duties of which he has ably performed. He is equally distinguished for private worth, literary acquirements, and proficiency in science.[7] His *Sketches of Turkey* places him far above the majority of travellers, and to it the reading world is indebted for a more faithful delineation of Turkish character and manners, than was ever before given. (Thompson 1918).

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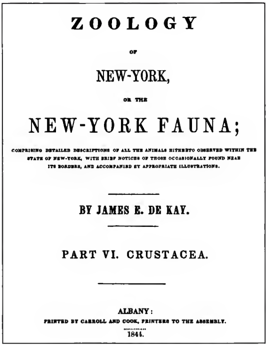
[6] George DeKay (1802–1849) had a thrilling naval career, mainly in the Argentine service in war against Brazil. He married Eckford's granddaughter, Drake's only child, in 1831. In 1847, he earned a government commission to sail a U.S. warship for relief efforts during the Irish famine. Among his seven children were notable soldiers in the Mexican and Civil Wars, and one significant author.

[7] Footnote in original: "The little brown harmless snake so common on Long Island has been named from Dr. Dekay, and is known as Dekay's snake."



ZOOLOGY

OF

NEW-YORK,

OR THE

NEW-YORK FAUNA;

COMPRISING DETAILED DESCRIPTIONS OF ALL THE ANIMALS HITHERTO OBSERVED WITHIN THE STATE OF NEW-YORK, WITH BRIEF NOTICES OF THOSE OCCASIONALLY FOUND NEAR ITS BORDERS, AND ACCOMPANIED BY APPROPRIATE ILLUSTRATIONS.

BY JAMES E. DE KAY.

PART VI. CRUSTACEA.

ALBANY:
PRINTED BY CARROLL AND COOK, PRINTERS TO THE ASSEMBLY.
1844.

Title page of DeKay's Zoology of New-York, . . . ; Crustacea *(1844).*

DeKay had taken an interest in the epidemics of Asiatic cholera, a disease that was then little known in America. His interest continued after his return to America, and he assisted as a physician when Asiatic cholera occurred in several large regions of the United States. Rafinesque, with many others, fled the scourge:

> Meantime [1832] the Spasmodic Cholera had appeared in Canada and New York, brought it is said from England or Ireland. This Epidemy alarmed me as much as the Yellow fever, to which it appears likely to succeed. I left Philadelphia with the Choleriue at the period of the explosion. I went again to Baltimore and without stopping hastened towards the mts. by the rail road of Frederictown thro' Patapsco hills, studying their Geology. I went direct to the point of rocks of the Cotocton mts. on the Potomac, across the curious vein of Conglomerate Breccia bordering them.
>
> Here not finding any conveyance into Virginia and the Apalachian mts. I had to go to Frederic, to take the western stage as far as Boonsborough over the Cotocton mts. forming here two ridges, with a broad valley between, where is situated Middletown, but to the S. it forks into 3 ridges.
>
> I went to Sharpsburg, the mineral waters of Belinda, to the Antictan Iron works, the banks of the Potowmak, &c. Returning to Boonsborough I remained there a week to herborize in the mountains. The choleriue only left me here. Well established I returned to Frederic over the mts. in a coach, and there took the stage for Emmittsburg to the N. in order to follow the foot of the mts. I rested there again, visiting the mts. and mineral waters, with the two Catholic institutions, the Monastic College of St. Mary; and St. Joseph Chief Nunnery of the Sisters of charity in America. They are the only Nuns who claim the good will of all men, they attended the sick during the Cholera in our Cities, with a religious zeal quite praise worthy. (Rafinesque, qtd. in Merrill 1944)

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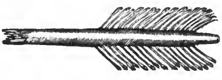


Its natural size, is but little more than half an inch long; the above figure is about six times magnified.
J. E. DEKAY.

JEDeKay
1826.

DeKay's (1822) figure of the terminal section of a Pennella *sp.; signature from DeKay's copy of Müller's* Zoologia Danica.

The great cholera epidemic of 1832 took three thousand lives in New York City alone (Kelly 1914).

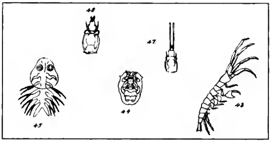
To DeKay, problems of medicine and medical practice were always secondary to natural history. We encounter him first as a copepodologist in DeKay (1822), a brief description of a parasitic copepod that he thought was a new genus but so baffled him that he did not know where in the animal kingdom to place it: "Dr. Mitchill was so obliging to submit to my inspection an animal found adhering to the *Diodon pilosus* of that gentleman" (DeKay 1822).

DeKay (1822) felt that "Cuvier pronounces perhaps too decisively" that these lernaeid forms were related to the crustacean *Caligus,* but "this is so palpable a blunder that it is very evident he had never seen the animal." (In this case, DeKay lived long enough to learn that he should never say "never.") DeKay's description included a fair figure of the terminal section, but the specimen was so mutilated that a subsequent identification was not possible;

Wilson (1917a) said that the only usable part of the description was the name of the host. DeKay's (1844) later *Pennella plumosa* is believed to be this species, now considered a synonym of *P. sagitta.*

DeKay was among the first to call for a nomenclatural code. With respect to copepods, even he did not adhere to his clear guidelines. Nevertheless, DeKay's influence probably kept others on or near the path of "sense and justice":

> It would much assist the cause of Natural Science if some general regulations could be adopted by which discoveries might be secured without infringing upon the rights of others, and a uniform system of nomenclature established. The Committee of Publication of the Lyceum have adopted for their own guidance the laws of nomenclature as collected by Decandolle in his Theorie de la Botanique. . . . There are several points not settled in that paper which are now generally received by naturalists, and indeed are obviously founded on principles of common sense and justice. Among these are,
>
> 1. Simple indications of species, merely to secure priority, should not be countenanced, although the specific name, if not otherwise objectionable, must be adopted.
>
> 2. As manuscript descriptions cannot be quoted, so the simple labelling of a specimen cannot be considered in the light of a prior claim. Yet courtesy requires that the original discoverer should be duly notified before publishing the species.
>
> 3. The claim of the original describer of a species is never lost, no matter through how many genera it may be successively transported.
>
> 4. Specific descriptions founded on single specimens are to be avoided as much as possible, and no description should be considered as complete and authentic, unless accompanied by figures, or what is preferable, a reference made to some collection in which the specimen is deposited.
>
> 5. No specific name should be noticed when the author has not himself seen the plant, animal, &c. but has drawn up his description from the relations of travellers.
>
> 6. Ignorance of the common systems, descriptions of species under two or more different names, the forming of new species from mere varieties of established and well known species, destroy all confidence in the authority of the describer, and of course render it unnecessary to quote his names or his descriptions, &c. &c.



Cecrops latreillii *Leach (Fig. 44) and* Caligus americanus *Pickering & Dana (male, Fig. 46; female, Fig. 47). The other figures are* Cerapus tubularis *Say, an amphipod (Fig. 43) and* Argulus alosae *Gould, an argulid (Fig. 45). From DeKay (1844).*

> These, and others of a similar character, although they may seem apparently unimportant in themselves, yet their due observance will tend materially to soften that exacerbation of feeling which should be confined to the political arena. (DeKay 1826)

A fine opportunity came to DeKay in 1836 when he was asked to direct the zoological aspects of an elaborate natural history survey of New York. He was absorbed in this project for eight years, publishing at the conclusion the *Zoology of New-York* in five volumes with a total of six parts (1842–1844). The *Zoology*'s subtitle added: "*comprising detailed descriptions of all the animals hitherto observed within the state of New-York, with brief notices of those occasionally found near its borders, and accompanied by appropriate illustrations.*" Even though this accomplishment takes us for a moment beyond the 1820s, DeKay's (1844) later copepod work, at least, was still slight and remained of a level comparable to that of the 1820s, except that lernaeids were by then recognized as crustaceans.

DeKay's accounts were formally presented to the governor: "I submit a continuation of a Report on the Zoology of the State. And have the honor to be, With great respect, Your obedient servant" (DeKay 1844).

DeKay's (1844) by now familiar literature list included the principal carcinological works from Linnaeus to Milne Edwards (1840) and A. A. Gould (1841), these last yet to receive their due in our narrative. I was pleased that DeKay referred to Müller's *Zoologia Danica,* since my copy had been proudly DeKay's since 1826.

The classification of crustaceans was fundamentally Latreille's from 1817, except that the two categories holding what we now would call copepods, the Lophyropa and Poecilopoda, had been raised to the order level. DeKay's (1844) list included some species that we have not yet encountered in our chronology:

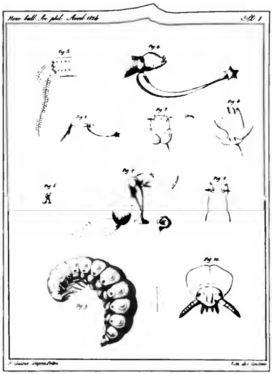
- Order Poecilopoda
  - *Caligus americanus* Pickering and Dana, 1838, with a poor figure of the male and female (his Figs. 46–47)
  - *Caligus piscinus* Latreille
  - *Caligus cristata* Gould, 1841
  - *Anthosoma smithi* Leach
  - *Pandarus sinuatus* Say (out of the New York area)
  - *Cecrops latreillii* Leach (out of the New York area); with a poor figure (his Fig. 44)

To make amends for past indiscretions, DeKay adds for the next poecilopods:

> The animals of [*Lernaea* and *Pennella*] have, . . . not withstanding their anomalous vermiform appearance, too many characters in common with the crustaceans, to leave them where they were originally placed. Some late writers have proposed to erect them into a distinct class between Insects and Worms. (DeKay 1844)

- Order Poecilopoda (continued)
  - *Lernaea* (*Lernaeocera*) *cruciata* Lesueur, 1824
  - *Lernaea* (*Lernaeocera*) *radiata* Lesueur, 1824
  - *Pennella plumosa* new species
  - *Pennella filosa* (out of the New York area)
- Order Lophyropa (both out of the New York area)
  - *Cyclops navicularis* Say
  - *Scopiphora vagans* new species

DeKay (1844) said that "I am indebted to my friend Dr. Charles Pickering for the . . . notes on this animal." Despite DeKay attributing the species to a Pickering manuscript, Pickering had not previously published this name, nor did he publish it later, so that for better or for worse it remains a DeKay species. Sadly, it was not at all well described—only that it is closely allied to *Cyclops*, is a minute crustacean, and is found abundantly in the deep water of Lake Ontario. Giesbrecht and Schmeil (1898) and Marsh (1933) believed *Scopiphora* to be the genus *Epischura* S. Forbes, 1882. We will once again encounter, in a subsequent volume, DeKay's "valued and learned friend Dr. Pickering" (DeKay 1844). Although the three copepod figures were very plain and not especially good, the larger crustaceans were handsomely drawn and printed in color.



Lernaeopoda salmonea *(Linnaeus, 1758) (Figs. 1–3) and* Lernaeopoda stellata *Mayor, 1824 (Figs. 4–8). From Mayor (1824).*

DeKay's preceding mollusk report summarized American conchology, giving credit to Michaux, among others, "and more especially of Bosc. . . . Within our own times, we are chiefly indebted to Thomas Say, who occupies in this department the same eminence which he attained in every other branch of Natural History to which he directed his attention" (DeKay 1843). DeKay still held the barnacles and tunicates in the mollusks, which "follows Cuvier." The other four monographs for the New York survey dealt with mammals, birds, reptiles/amphibians, and fishes.

In 1842, in his *Zoology of New-York,* DeKay named and described the curious blind cavefish, *Amblyopsis spelaeus,* new genus and species, from Mammoth Cave, Kentucky. This fish was later found in Wyandotte Cave, Indiana, where it was host to a new genus and species of parasitic copepod, *Cauloxenus* *stygius* Cope, 1872. In respect to DeKay's work with fishes, Theodore Nicholas Gill (1837–1914) named the sharp-nosed mackerel shark *Isurus dekayi.*

> Dr. James E. Dekay wrote the article entitled "A Catalogue of the Birds of Long Island," that was published in the second edition of Thompson's *Long Island,* and was dated June 1, 1843. Dr. Dekay was one of the few scientific ornithologists of his day, and probably the only person who could have compiled as good a list of Long Island birds at that time. . . . Of the 404 known United States species in 1843, Dr. Dekay named 293 as known on Long Island. Today (1917), of the 1,115 varieties recorded by the American Ornithologist's Union, 372 are included in the . . . Long Island list. (Thompson 1918)

In 1853, DeKay published a *Catalogue of the Cabinet of Natural History of the State of New York.* Agassiz (1850) recorded nine other DeKay publications, covering geology, invertebrate fossils, mammals, and the progress of natural history. Goode (1901c) included DeKay as one of eight American "leading spirits" of the century's fourth decade. DeKay spent his remaining years at "The Locusts," his home on Oyster Bay, Long Island, where he died in 1851. "In the social relations of life, his uprightness, amiability and cheerful temperament, endeared him to all who shared in his acquaintance" (Anon. 1852).

> Green be the turf above thee,
> Friend of my better days!
> None knew thee but to love thee,
> Nor named thee but to praise.
> —*On the Death of Joseph Rodman Drake,*
> FITZ-GREENE HALLECK (1847)[8]

François Isaac Mayor

16 May 1779–4 October 1854

Mayor is another French-writing copepodologist with no published first name. Some subsequent authors have registered him as "M." Mayor, which is undoubtedly true, but perhaps not biographically significant. Monsieur Mayor (1824) published only a single short paper on copepods, in the *Bulletin des Sciences* of the Société Philomatique of Paris. This was abstracted in the *Bulletin des Sciences Naturelles et de Géologie* (issue no. 2, pp. 223–24) of the same year, with some editorial comments comparing the egg strings of lernaeopods with those of chondracanthids. Mayor (1824), written in the third person, informed us that he was one of the administrators of the Geneva Museum and a corresponding member of the Société Philomatique. He had found the 2.5-line (5.6 mm) long *Lernaeopoda salmonea* on all the fins of *Salmo umbla,* a very common fish in the Lake of Geneva; it was from this occurrence that Mayor attached it to de Blainville's earlier "Lerneopod of salmon." Mayor also thought this was a species described by Baster. He described the appendages, egg strings, and the contractions of the heart, and provided three figures. Both de Blainville and Mayor believed that this was the same as Linnaeus's species, but Wilson (1915) said that Mayor's species was likely the closely related *Salmonicola edwardsii* (Olsson, 1869).

François Isaac Mayor (1779–1854). From Olivier (1945).

Mayor (1824) also described a new species, as the title of his paper promised: this was *Lernaeopoda stellata,* found in Norway fixed to the fins of a juvenile sturgeon (Desmarest 1825). Mayor provided five figures of this seven-line (16 mm) long species and described the three-part body, the antennae, and the mandibles. Yamaguti (1963) said that this species remains as the type of *Pseudotracheliastes* Markewitsch, 1957.

Mayor of copepod literature has puzzled me for many years. Even in the last stages of this draft, I was frantically pursuing clues as to his identity. Only a year before, with the new magic ability of searching worldwide library catalogs from the comfort of one's own home, I listed some possible Mayors from the appropriate time and place. The first was Mathias Mayor (1775–1847), internationally known chief surgeon at the Canton Hospital in Lausanne, at the north end of the Lake of Geneva. He had obtained his M.D. from the University of Pavia in 1795. From the publications revealed to me, it seemed unlikely that he was the author of the copepod paper or an associate of the Geneva Museum. A review of French ichthyology of the period (Bauchot, Daget, and Bauchot 1990), however, recorded Swiss physician "Matthias [*sic*] Mayor" of this time as being an author of papers on fishes of Switzerland, as well as being a "Conservateur du Cabinet de Genève." This certainly pointed to Mathias Mayor as the copepod Mayor. An extended search revealed two accessible biographies (Delay 1915, Gerster 1968) of this worthy medical man, remembered for introducing or promoting several innovations, like cotton bandages and gauzes, that we take for granted today. Although Mathias Mayor was a member from 1818 of the Société des Sciences Naturelles Helvétiques, there was no mention of the Geneva Museum of Natural History, nor of authorship or special interest in natural history. Mathias Mayor was occasionally in Paris and went to England in 1826, but his activities seemed always related to surgical science.

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[8] Both men were DeKay's friends.

I must interject here that I had long known that Louis Agassiz's grandfather was one Jean Daniel Mayor (1752–1830) (Agassiz 1887). However, I had rejected Daniel Mayor as the "copepod Mayor" because of age and geography. Supporting my Theory of Infinite Connections, the inspection of Mathias Mayor's life revealed that he was the first child of the same Daniel Mayor, physician (Olivier 1939). The last of Daniel Mayor's six children was Rose Marianne Mayor (?–1867), who married Pastor Louis Rodolphe Agassiz (?–1837). Their son, Louis Agassiz, fondly remembered his Mayor grandfather, uncles, and cousins, and these strong family ties appreciably increased the difficulty of his departure to America.

Not long ago, I discovered the Mac Arthur (1990) account of the physician Berger, student and friend of Jurine and friend of Delaroche. This paper provided the key to my long sought-after information on Delaroche, but it also mentioned the author of an 1833 obituary of Berger, one "F. Mayor." One of my previous potential subjects was an F. Mayor, one of several physicians of Geneva who authored a three-volume review of foreign surgery in 1824. There was also a no-first-name Mayor of 1837 who published an account of medical services in penitentiaries.

I have now been informed by Mr. Mac Arthur (pers. comm., December 1997) that our copepod Mayor can be none other than François Isaac Mayor, M.D., the friend of Berger and author of the above-mentioned obituary. Around 1816, Berger and Mayor shared the duties of Secretary of the Société du Samedi, a local organization for physicians. Mayor was also said to be a founder of the Geneva Museum.

Even now, I have no incontestable proof that François Mayor is the man for this book, but all evidence suggests this. Two factors worked together to ensure this uncertainty. First, of course, was François Mayor's modesty in not signing his full name to his publications. This practice, perhaps in the majority of cases, could be looked upon either as an inverse snobbery or an egalitarian response to the Revolution. However, an evaluation of F. Mayor's relatively few publications, his offers of manuscripts for others to publish, and his predilection for spoken reports rather than written, point to a decided aversion to publishing and to any accompanying notoriety (Olivier 1945). The second camouflaging factor was the incredible parallel between François and Mathias Mayor within medical science. François Mayor, from the south end of the Lake of Geneva, was virtually assured of oblivion through the unlucky fact that his equally then-well-known contemporary had the name "Mathias." The custom in French-language journals of referring to M. Someone-or-Other left countless printed references to "M. Mayor." Over the years, many reviewers have mixed the comparable backgrounds and accomplishments of the two men. In deciphering "M. Mayor," it had been convenient to look to this coincidence-compounded and to equate M. Mayor to the known Mathias Mayor. Olivier (1945) has given several examples of this error, and I have noted others. It would not be the first time that one man received the credit for what another had done.

François Mayor differed most from Mathias Mayor through the former's dedication to natural history. François Mayor's known long involvement with the Geneva Museum, the establishment of his natural history cabinet (given later to the museum), and his manuscripts and publications on invertebrates are in strong contrast to the life of Mathias

Mayor. In 1822, François Mayor lectured on fish and reptiles at the Geneva Museum; he also published on salmon restorations and on tapeworms and left manuscripts dealing with sponges and fossil cephalopods (Olivier 1945).

François Mayor's family in the Pays de Vaud (canton of which Lausanne is the capital) provided at least two surgeons in the seventeenth and eighteenth centuries and "three physicians of high merit" in nineteenth-century Geneva. One of these three was François Mayor, from a family of judges, attorneys, army officers, and physicians traced back to 1510 (Olivier 1939). After François, the family continued to provide well-known medical men up to recent times (Olivier 1945).

François Mayor was born at Château de Biere in Canton Vaud. After an indifferent elementary school education, his father, a commissioner of lands, apprenticed him at age fourteen to the chief surgeon of the hospital at Bern. Mayor continued his apprenticeship there and in Zurich until 1796.

After a short stay with a surgeon uncle in Vevey, Mayor went to Paris. To fulfill his military obligation, he served as surgeon-major with duties mainly in Switzerland during the campaign of 1798. He returned to Paris for an additional two years of study before going back to Switzerland in 1801. He was certified at the College of Medicine in Lausanne for a medical practice, which he began in Vevey in 1802.

Mayor left Vevey in early 1808 to seek his medical degree at the University of Montpellier under de Candolle, Professor of Botany. With his excellent background, recommendations, and certificates, Mayor needed only to submit his thesis on congenital eye diseases. He was awarded the doctorate in an astonishing few months. Mayor, introduced to Cuvier by de Candolle, then worked with Cuvier in Paris until the end of November. It was the contact with these two naturalists that steered Mayor into natural history.

François Mayor next joined a brother and many friends in Geneva and became one of the city's most honored citizens, serving as an active member of city government until his death from a massive stroke. Mayor was planning to preside at a Health Council meeting on the day he died. He left a magnificent library of rare works of medicine and natural history (Olivier 1945).

François Mayor's medical practice thrived, and with his associates he revitalized the surgical and medical societies of Geneva. He was a member of the Faculté de Medicine de Genève. In 1818, Mayor was the first to report on the beating of the heart in the human fetus (in this case, his own son).[9] Mayor was content to relay this significant information to his colleagues where it was published in the proceedings of the local medical society, ensuring its omission in most subsequent reviews of medical milestones. Two or three other physicians, including René Laennec (1781–1826), are usually given this credit (Garrison 1914, Olivier 1945).

Olivier (1945) said that F. Mayor was a "membre associé des Sociétés de biologie . . . de Paris." This could refer to the Natural History Society of Paris, renewed in the 1820s (Agassiz 1848), or it could refer to the Société Philomatique, of which both Cuvier and de Candolle were keen supporters and leaders. The list of members of the Société Philomatique for 1824 included a "Mayor" of "Genève" as a corresponding member. The 1824 copepod paper in its *Bulletin des Sciences* was by corresponding member "M. Mayor."

François Mayor was a founding member of the Swiss Society of Natural Sciences in 1815 (Olivier 1945). When the Swiss Society of Natural History was derived from that parent in 1817, F. Mayor was an enthusiastic contributor. Regarding his relationship with the Geneva Museum of Natural History and to the copepod paper, a colleague stated that

> I am quite sure that you are right: it is François Isaac and not Mathias. As far as I could see, Mathias did not have any important contact with Geneva (he apparently never was a member of the Société de physique et d'histoire naturelle which initiated the foundation of the Swiss Society of Natural History, and I could not find any trace of connection with the Geneva Museum), but F. I. Mayor was one of the founding members of the Musée academique Genève (the common ancestor of all the scientific museums of the City) (at this time the museum was directed by a scientific council constituted mainly by its founding members). (Volker Mahnert, pers. comm., January 1998)

Finally, François Mayot was a founding member of the Society of History and Archaeology in 1838 and was the first to report on fossils and artifacts of ancient man in the Geneva region (Pittard 1929, Olivier 1945).

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[9] The son, George François Isaac Mayor (1818–1899), called Isaac, was a distinguished surgeon and Professor of Anatomy and Physiology.

Mr. Mac Arthur also provided a reference to a curious episode with an elephant in Geneva, which revealed something about Mayor and his times (Anon. 1820c). As noted often, persons who have studied copepods are a varied lot, and nothing seems beyond their collective interest in the natural world. This elephant, from India and not an African remnant from Hannibal's crossing of the Alps, was brought to Geneva by a circus troupe. The elephant, ten years old, was owned by a Londoner whose niece was its keeper. The lady was strongly attached to the animal and was able to have it perform a number of impressive feats on command. During its stay in Geneva, many citizens were attracted by the elephant's docility and intelligence. The tale plays out amid bad luck and stupidity, always frightful combinations. The elephant was frequently disturbed there by "décharges de mousquetterie," from adjacent military exercises. Efforts to control the elephant by the handlers, in the absence of its mistress, only made matters worse. Eventually the summoned lady was able to quiet the upset animal, but by then the city authorities were alerted and there was much needless hand-wringing and despair. The handlers quit and the lady was given two choices: have the elephant shot or have it poisoned.

I would have enjoyed a happy ending for this pathetic story, but despite the entrance now of "Mr. Mayor, distinguished surgeon, well-informed amateur of natural history, and one of the Directors of the Museum," the event rapidly became a spectacle of foregone tragic conclusion. Mr. Mayor was François Mayor, who had often visited the elephant, often enough so that the latter had developed "a particular sort of affection for him" (Anon. 1820c). The town's magistrate asked Mayor to administer poison, but Mayor voiced extreme repugnance to such a treacherous act. His refusal to take part caused the magistrate to invoke some law of the greater good of the people, probably together with a threat to revoke Mayor's medical license. Mayor acquiesced.

The selected poison was prussic acid (cyanide), three ounces delivered in brandy, "the animal's favorite liquor." There was no effect. It was later believed that the poison was too old to have been effective. Commanded to make a second try, Mayor administered three large sugar-balls, each with an ounce of arsenic. A quarter of an hour passed without effect. By this time there were such throngs of the "public curieux" that the elephant could not, it was believed, be safely escorted away. And so the inevitable order was given to fire, and the charade was mercifully ended with cannon from the obliging troops.

The owners of the late elephant arranged to give its remains to the museum. Mayor dissected it over the next several days, assisted by a student from the Veterinary School at Alfort. To satisfy another curiosity, "three or four hundred individuals" ate some of the meat, without experiencing any untoward effects (it was assumed that the poisons had not had time to reach the musculature) (Anon. 1820c). The episode of the elephant was eventually turned to some positive publicity for the Geneva Museum of Natural History, where, it is said, the skeleton remains to this day.

Sigrist (1995) included François Mayor among Louis Jurine's disciples in surgery as well as natural history. They also had at least one close friend in common, the polymath Marc Auguste Pictet (1752–1825). Of course, when the Mayor copepod paper appeared, Jurine had been dead about five years. François Mayor will yet secure his proper recognition. Without detracting from Mathias Mayor, his contemporary and unrelated homonym, François Mayor can be justly remembered as an outstanding physician/naturalist, historian, public leader, and ardent patriot of the early nineteenth century.

Charles Alexander Lesueur

1 January 1778–12 December 1846

The romantic life of the already introduced Charles Alexander Lesueur began and ended at Havre-de-Grace (now Le Havre), France. It is most fortunate that he wrote a paper about copepods so that he can have a place of his own in this long narrative. Lesueur's father and grandfather had been career administrators in the admiralty at Le Havre (Manneville 1979). Lesueur probably had some modest schooling in topographical drawing, at which he excelled; he had an obvious early interest in natural history. To satisfy both pursuits, and to answer a call of the sea, he presented himself as a volunteer for a prestigious French scientific voyage that was to begin in October 1800. The Baudin Expedition, named after its commander, was to be a journey of discovery to Terra Australis, the lands of the South Seas. French expeditions at the time were in response to England's aggressive colonization.

When Lesueur offered his seemingly meager resources, the expedition's naturalist and artist contingents were fully formed; the only opening was for a gunner's aide (Bonnemains 1989). Undaunted, the twenty-two-year-old unknown signed on for the lower decks. Soon after departure, however, Lesueur's considerable abilities as an intuitive naturalist and his extraordinary talent as an artist earned him a place with the scientific corps. Even Baudin appreciated Lesueur's talents and allowed him to illustrate Baudin's logbooks (Bonnemains 1983a, 1986a).

This expedition is remembered for the contemptible behavior of Commander Nicolas Baudin (1750–1803), who had no virtues whatsoever, especially concerning leadership of a scientific enterprise. Among his repulsive qualities were selfishness, arrogance, and malignity, and an abundance of self-confidence born of ignorance. The vulnerable Lesueur might not have survived at all, much less with any scientific credentials, if it had not been for François Péron (1775–1810), a physician and zoologist of the Baudin Expedition. Péron had served in the army during the Prussian wars; he had been wounded and, during a long captivity, lost his right eye. Freed by an exchange of prisoners, he turned to the study of medicine and natural history (Cap 1854). It was Péron who recognized the unaffected talents of Lesueur, and the working combination of these two shipmates not only enabled both to survive but to accomplish some credible scientific work. Péron later called Lesueur "the companion of my work, and of my misery" (Bonnemains 1989).

Contrary to all laws, written and otherwise, whenever Baudin brought his two ships *Le Géographe* and *Le Naturaliste* into a foreign port, he promptly put out a "for sale" sign and sold, for his personal profit, anything that was not bolted down. This included ship's provisions, medical supplies, scientific apparatus, and chemicals. Of the ships-company that did not desert, fully half died. By the end of the cruise, in Australian waters, the ships were manned by living dead. It is only fitting that Baudin was likewise sick among them, and that he died there and then. Baudin was eulogized by Péron as "a miserable wretch" (Ord 1849).

These three and a half horrible years (1800–1804) were a crucible for the testing of personal strength and scientific zeal, a test that most, blamelessly, failed. The initial party of four zoologists and three botanists held two of our acquaintances: one was André Michaux, the eminent botanist and friend of Bosc; the other was the sainted boy-hero, zoologist Bory de Saint Vincent. Michaux and Bory jumped ship in Mauritius in March 1801, along with the three official artists. Bory lived to publish a scientific account of the voyage to that point (Hagen 1862). Michaux made his way to Madagascar, giving that remarkable island only slight botanical attention before he died there, succumbing to tropical fevers. Two other zoologists and a botanist stayed with the ships but died on board. That left only Péron and the greenhorn-turned-naturalist Lesueur. The multitalented Lesueur—sturdy, resourceful, and well-dispositioned—was nearly put in the grave by a poisonous snake in Timor. Péron was sorely tried and in broken health by the whole ordeal.

By the time the expedition limped home in March 1804, it had become a national scandal best forgot-

François Péron (1775–1810), as drawn by Lesueur in 1810. From Pilleri and Arvy (1981); signature courtesy of Museum of Natural History, Le Havre.

tout à vous de cœur et d'amitié
Lesueur

Charles Alexander Lesueur (1778–1846). From Jordan (1895), after an original painting by Charles Willson Peale now at the American Philosophical Society; signature from letter to Desmarest, 14 May 1817, Letter 65033, Museum of Natural History, Le Havre.

ten. No one imagined that anything good would come from it. The scientific community looked to other matters, any of which they believed would be more important. The Péron/Lesueur team nevertheless turned to the essential task of unpacking and cataloging. After Baudin had sold the preserving alcohol, Lesueur and Péron utilized arrack, a strong local drink made from fermented coconut milk (Cap 1854), and it was clear to Péron and Lesueur that this had been effective and that they had returned with many interesting specimens. With nothing further to lose, they appealed directly to the Academy of Sciences.

The academy's committee, including Cuvier, Laplace, Lacépède, and Bougainville, reported after reviewing the collection that

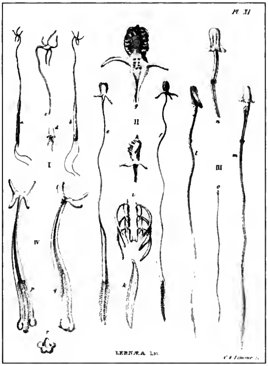
> the extent and importance [will] become more and more manifest. It is composed of more than one hundred thousand specimens of animals, several of which will constitute new genera; and the new species, according to the report of the Professors of the Museum, are upwards of two thousand five hundred. If we call to mind that the second voyage of Cook, fruitful as were its discoveries, made known not more than two hundred and fifty new species, and that all the united voyages of Carteret, Wallis, Furneaux, Mears, and even Vancouver, did not produce as great a number—it results that Péron and Lesueur alone have discovered more new animals than all the traveling naturalists of modern days. . . .
>
> Such are the labors, as numerous as they are interesting, of which you have appointed us to render you an account. They receive additional value from the unfortunate circumstances in the midst of which they were performed. Notwithstanding the foresight and orders of the government, privations of every kind bore heavily upon all the individuals attached to this great enterprise. . . . Of the twenty-three persons . . . for divers scientific researches, three only have returned to their native land, after having accomplished the entire voyage. Some, early discouraged, abandoned the expedition; others have remained sick at different places; the remainder are no more. Surrounded by so many disasters, Péron and his constant friend never allowed themselves to be overcome; at every epoch of the voyage they manifested the most honorable attention to their duty. (Report to Academy of Sciences, 1806, qtd. in Ord 1849)

Péron, with Lesueur and one or two others, was commissioned to publish the narrative and the scientific results. Péron and Lesueur were awarded pensions. Some preliminary volumes were completed after much effort, which left Péron in poor health. In 1809, Lesueur took him to Nice for a rest cure, although they found themselves "naturalizing" as in the expedition years. Perhaps nothing would have saved Péron by that time; he returned to Paris just as ill and shortly thereafter died (Cap 1854). The principal work that Lesueur and Péron had envisioned, the magnificently illustrated medusae of the Baudin Expedition, remained unpublished for nearly two hundred years (Bonnemains and Breton 1995). Suriray, already mentioned, was a collaborator on this extensive project.

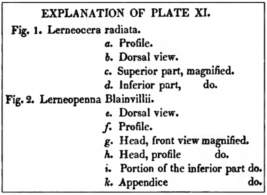
Without Péron, Lesueur lost much of his drive and direction. He collaborated with Bosc, Desmarest, and Duméril. In 1812 and 1814, he and Suriray collected on the shores around Le Havre. Lesueur published his first paper on fishes in 1814, including a description of a new species from Nice, *Callionymus risso,* named for a friend, Risso, already a distinguished part of our story. Also in 1814, Lesueur became a member of the respected Société Philomatique de Paris.

Napoleon's decline left Lesueur temporarily without his pension. In 1815, William Maclure, the geologist, passed through France and met Lesueur. Maclure, preparing for a scientific return to America by way of the West Indies, asked Lesueur to accompany him as a companion naturalist. Lesueur accepted, was appointed a correspondent of the Museum of Natural History (Paris), and spent the next two years with Maclure in the West Indies and the eastern United States amassing a large portfolio of fish, invertebrate, and scenic drawings (Bonnemains 1984, 1986b). By 1816 the two arrived in Philadelphia, where Maclure had his home (Ord 1849).

Lesueur was welcomed into the budding scientific community of Philadelphia. By then needing to convince no one of his artistic abilities, Lesueur had nevertheless brought with him, to the dismay of France, all of his colorful paintings from the Baudin Expedition. To earn money in the New World, Lesueur gave drawing lessons. In those days, there was not so sharp a distinction between art and science as there is now; Lesueur often exhibited in both the art and the scientific academies. His work was so precise that he was said to have offered a magnifying glass to admirers so that they could detect the fine details (Poesch 1961).



Parasitic copepods drawn by Lesueur (1824).



EXPLANATION OF PLATE XI.

Fig. 1. Lerneocera radiata.
a. Profile.
b. Dorsal view.
c. Superior part, magnified.
d. Inferior part, do.
Fig. 2. Lerneopenna Blainvillii.
e. Dorsal view.
f. Profile.
g. Head, front view magnified.
h. Head, profile do.
i. Portion of the inferior part do.
k. Appendice do.

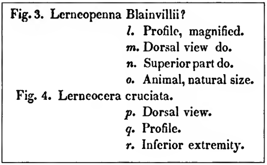


Fig. 3. Lerneopenna Blainvillii?
l. Profile, magnified.
m. Dorsal view do.
n. Superior part do.
o. Animal, natural size.
Fig. 4. Lerneocera cruciata.
p. Dorsal view.
q. Profile.
r. Inferior extremity.

Lesueur was present at the incorporation of the Academy of Natural Sciences of Philadelphia in 1817. He donated many French publications to the academy and was a substantial contributor to the cosmopolitan flavor of the new society. The academy had actually begun in 1812, with three of the seven founders foreign-born. One was Maclure; another was Gerard Troost, from Holland. Troost, academy president for five years, had been a student of the mineralogist Haüy in Paris. For the year 1818, Maclure was president and Ord, Lesueur's biographer, was vice-president. The first issues of the academy's journal list three "curators": Thomas Say, Titian Peale (who will figure prominently in the story of James Dana), and Lesueur.

Lesueur was again in his best element and found himself the enthusiastic partner in some extraordinary early-American biological explorations. He described his activities in letters to his friend Desmarest (Bonnemains 1989). With Nuttall (plants), Ord (birds and mollusks), and Say (crustaceans, insects, and mollusks), Lesueur (fish) formed a miniature but effective biological survey. Their integrated impact was astounding (Ord 1849, Goode 1901b, Leroy 1957). It was probably Lesueur who introduced Say to marine in-

Mr. Charles Alexander Lesueur
Naturalist
from life by J. Chappelsmith 1826.

Silhouette of Charles Alexander Lesueur drawn in 1826. Courtesy of the collection of Historic New Harmony, a unified program of the University of Southern Indiana and the Indiana State Museum & Historic Sites.

Engraving of Lesueur based on Carl Bodmer's painting. From Bonnemains (1992). Note the additional dogs and that the new artist gave Lesueur a beard!

vertebrates (Goode 1901b). Say, Nuttall, Peale, and Lesueur were consummate collectors, sharing with others what they did not need for themselves.

The first issue of the *Journal of the Academy of Natural Sciences* held numerous Lesueur articles, and he remained a regular contributor through the first five volumes. Most of these articles were descriptions of new species of fish from eastern North America and the Great Lakes region. The very first paper in the *Journal,* published in May 1817, described a pteropod (pelagic mollusk) that Lesueur and Péron collected at Nice in 1809. Lesueur made several references to a planned work on "Fishes of the United States of America." This would have been a landmark publication, as evidenced by Lesueur's nicely illustrated smaller papers on fish. However, the grand monograph never fully materialized. Lesueur's fish reports and miscellaneous articles are listed in Ord (1849), Agassiz (1853), and Bonnemains (1983b). One of Lesueur's fish, collected near New Orleans by Nuttall, was *Mollienisia latipinna,* new genus and species from 1821. This is today a favorite aquarium fish, and, indeed, I was a proud caretaker of my first pair when I was sixteen years old.

Lesueur produced the first two lithographs in the United States for the *Journal* in 1822 (Poesch 1961). That year he also became a member of the revitalized Natural History Society of Paris (Bonnemains 1986b).

Lesueur's (1824) single claim to copepod fame, other than his undoubted help to Say and others, was his paper describing and illustrating three new species of parasitic "vermes" belonging to the Linnaean genus *Lernaea.* In spite of the title, Lesueur followed the erroneous usage of his countryman, de Blainville (see Chapter 14), by placing the first two species in the genus *Lernaeocera* and the third in *Lerneopenna.* The first species, *Lernaeocera cruciata* from Lake Erie, is now back where it belongs, in the Linnaean genus *Lernaea.* For the second species, *Lernaeocera radiata* from the Atlantic coast menha-

Lesueur's house (left center, with four windows fronting Church Street) and "The Hall" at New Harmony, Indiana, drawn by Lesueur. From Bonnemains (1984), Collection Lesueur, Le Havre, Drawing 41 160).

den, Lesueur proposed a new genus, *Lernaeenicus,* and it remains there to this day as *Lernaeenicus radiatus* Lesueur, 1824 (see Wilson 1917b, Kabata 1979). In respect to the discomfort to the fish noted by Baker and others, Lesueur chose this genus name as a combination of *Lernaea* and "enico," which means to torture! The last species, *Lerneopenna blainvillii,* also from the Atlantic coast, has usually been considered synonymous with *Pennella exocoeti* (Holten, 1802) (see Wilson 1917b). Lesueur found a second and similar specimen on the same flying fish; he thought, erroneously, that it might be the male.

An account of an 1825 meeting of the academy was recorded in a letter:

> A few evenings since I was associated with a society of gentlemen, members of the Academy of Natural Sciences. There were present fifteen or twenty. Among the number were Le Sueur, Rafinesque, Say, Peale, . . . and Charles Lucien Bonaparte.
>
> Among this collection life was most strikingly exemplified: Le Sueur, with a countenance weather-beaten and worn, looked on, for the muscles of his ironbound visage seemed as incapable of motion, as those on the medals struck in the age of Julius Caesar. Rafinesque has a fine black eye, rather bald and black hair, and withal is rather corpulent. I was informed that he was a native of Constantinople; at present he lives in Kentucky. . . . Peale is the son of the original proprietor of the Philadelphia Museum, and one who visited the Rocky Mountains with Major Long; he is a young man, and has no remarkable indications of countenance to distinguish him. Say, who was his companion in the same expedition, is an extremely interesting man; to him I am particularly obligated for showing me their Museum and Library. I think he told me that their society had published nine volumes. . . . Bonaparte is the son of Lucien Bonaparte and nephew to the Emperor Napoleon; he is a little set, black-eyed fellow, quite talkative, and withal interesting and companionable. (Herrick 1938)

When Robert Owen and Maclure enticed the "boatload of knowledge" toward the imaginary benefits of New Harmony in December 1825, Lesueur accompanied them, no doubt from his sense of duty as well as for his strong friendship with Say. For awhile, New Harmony took on the aspect of a field station attached to the Academy of Natural Sciences. Lesueur, a virtual walking camera, left many wonderful sketches from their journey to, and from in and around, New Harmony. Any one of these would be a treasure; many have been reproduced by Bonnemains (1992, 1993) and Stroud (1992).

Charles Alexander Lesueur as painted by Carl Bodmer at New Harmony in 1833. Courtesy of the Joslyn Art Museum, Omaha, Nebraska; Gift of Enron Art Foundation.

Although Lesueur continued his collecting on behalf of his associates, his publications were few in this period. He explored in Missouri, Illinois, and Tennessee. In 1826, he boated down the Mississippi to New Orleans, a voyage that took one month, collecting fishes as far as Lake Pontchartrain and making drawings for his anticipated monograph. He sent many specimens to the Museum of Natural History in Paris, where he remained a corresponding member. In 1827, Lesueur printed, on the press at New Harmony, sixteen pages of text with eight of a planned forty-eight plates of his *American Ichthyology, or, Natural History of the Fishes of North America* (Bonnemains 1983b, 1989; Roux 1983). Sadly, the rarity of this publication left it with little influence. As with other talented people and grand schemes, time simply got away from Lesueur as he continued to do much for others. He needed Say to help his writing, but Say was also running out of time. As the years went by, Lesueur watched his new fish species being described by others.

Lesueur went again to New Orleans in 1837, this time crossing paths with Audubon who was on his way from Georgia to Texas. Having met first in Philadelphia in 1824 when Audubon made his naturalist's debut, and again at New Harmony, they had much to talk about. But this was their last meeting, for "good M. Lesueur," with his drawings and collections, was on his way back to Le Havre (Ord 1849, Herrick 1938, Leroy 1957).

Lesueur had little to keep him in New Harmony after Say died in 1834. Although Goode (1901c) declared that these twelve years were sacrificed to the theoretical society, I believe that Lesueur would not have considered them wasted. One must admit that there is more to life than a long list of publications. Lesueur was instrumental in founding a natural history museum at Le Havre, which remains the caretaker for his drawings and collections. He was named to the Royal Order of the Legion of Honor in 1845 (Bonnemains 1989). Lesueur died at Le Havre in 1846. Perhaps we have not heard the last of Lesueur; his complete portfolio of North American fishes may yet see the light of day. Likewise, a great many Lesueur crustacean drawings remain to be published (Bonnemains and Jones 1990).

Goode (1901c) considered Lesueur the "Raphael of zoological painters," saying that "no one ever drew such exquisite figures of fishes." This praise cannot be overlooked in light of Goode's own enormous contributions to American fish and fisheries. Lesueur, Say, and their colleagues must be counted among the most distinguished of the early naturalists in America.

Jean Baptiste Geneviève Marcellin Bory de Saint Vincent

6 July 1778–22 December 1846

Bory de Saint Vincent has twice crossed our copepod path. We first praised him as the alert adolescent insect hunter who saved Latreille from certain death in 1793. Next, he and Lesueur were on different vessels on the first leg of the botched Baudin Expedition in 1800–1801. Fate decreed that Bory would belong on the fringes of our narrative in any case, for he compiled a single summary of the lernaeids for one of the many popular French "dictionaries" of the time. But in the world beyond copepods, Bory would be remembered best as a geographer and exploring naturalist (*Webster's* 1960) and as a zoologist of considerable range and acuteness of experience. His life also included episodes as one of Napoleon's frontline officers, an outlaw, and a convict.

J.B.BORY DE SAINT VINCENT
(Voyageur, Zoologiste, Botaniste et Géographe),
Membre correspondant de l'Académie
des Sciences de Paris etc.

Jean Baptiste Bory de Saint Vincent (1778–1846). From Lauzun (1912). Courtesy of Harvard University Library.

Born as a baron into minor nobility and a respected family of lawyers, Jean Baptiste Geneviève Marcellin Bory de Saint Vincent's circumstances and potential would have been envied by many. Bory's father was a high officer in the finance ministry. Agen, Bory's birthplace, southeast of Bordeaux, was a sandy and marshy paradise that indulged his hereditary tastes for natural history. As a youth, Bory chased insects and collected plants, and compared them with those in the extensive cabinets of a grandfather and an uncle, Auguste Journu. Bory grew up surrounded by showcases of shells, insects, plants, minerals, and scientific instruments. Bory corresponded with the region's naturalists, and through his uncle he had met Lacépède. He also knew of the Danish entomologist Fabricius, and also was aware that Latreille was revising the Fabrician genera. By 1793, Bory was living with his uncle Bernard Journu in Bordeaux when he learned of Latreille's imprisonment. Bory notified his father and uncle, and with the help of the director of the Bordeaux museum they freed Latreille (Castera 1987; Bauchot, Daget, and Bauchot 1990).

Shortly after this moment of influence, The Terror struck at the Bory de Saint Vincent and Journu households. Due to their aristocratic status, Bory's father and uncles were arrested and imprisoned. Because his personal letters contained an unusual number of erasures, the tribunal believed that Bory's uncle Auguste must have been guilty of atrocious crimes, and he was guillotined in early 1794. After the climactic 9 Thermidor (27 July 1794), the imprisoned family members were released (Castera 1987).

Though it was not entirely safe, the military provided a kind of haven for any young man who stayed in France. It was also a way for noble youths to "redeem" themselves in the new republic of liberty, equality, and fraternity (Elting 1988). For this reason, Bory served in the army, mostly in Germany, from 1795 to 1798. In 1799, he was sent to the Army of the West, where he was a lieutenant on the general staff. Unexpectedly, Bory was able to keep his hand in natural history matters (a lifelong attribute), and in 1800 he was named as a correspondent of the National Museum in Paris. Through the intercession of powerful friends, in particular Lacépède, he was able to leave the army in April 1800 to join the Baudin Expedition, then outfitting in Le Havre (Toussaint 1941; Bauchot, Daget, and Bauchot 1990).

Bory was assigned as chief naturalist on the corvette *Le Naturaliste,* while Baudin, Péron, and Lesueur were on *Le Géographe.* When the ships stopped at Mauritius in 1801, Bory boarded the commander's vessel and at once saw a group admiring the drawings in Baudin's logbooks, illustrations by Lesueur,

> a young man of modest demeanor, who by a noble zeal, had embarked as a novice helmsman, although worthy to form a part of a scientific expedition, in a manner much more useful to the progress of the arts. His talents had been discovered on board of the ship, and the commander-in-chief had availed himself of them by giving him employment. I have since been informed, that strict justice having been done him, his appointments have been assimilated to those of the principals in each department; and he truly merited this encouragement. The skillful young man was one of the expedition's greatest resources. (Bory de Saint Vincent 1804, qtd. in Ord 1849)

Although it was recorded that an illness prevented Bory and some others from continuing on the expedition, it was in fact Baudin's irrational behavior and lack of leadership qualities that drove so many from the ships (Ord 1849, Toussaint 1941). Péron himself said:

> Unfortunately, the majority of the others among us who were not able to accommodate the violent, despotic, and crude character of the chief deserted at the Isle of France [Mauritius], and the rest, with the exception of two or three, perished in succession, victims of the privations and of the mortifications with which M. Baudin tested them. It was this way up to the end of the 1st campaign [when] I and all the naturalists at last embarked on board the "Géographe." I had, Alas!, in turn closed the eyes of my friends, of my colleagues.
>
> What was to have shown, moreover, how much all the persons selected by the Institute were deserving of its confidence, became nothing of the kind; whether they had remained with the expedition or whether they had abandoned it, they could not gain by their effort and their pain the rightful gratitude of the nation and of science. (Péron, MS "Composition of the Expedition," Le Havre Museum)

The French colony at Mauritius was just coming out of a long period of wartime deprivation and a struggle with the home government over slavery. The social conditions, therefore, were favorable to a thirty-year-old proposal for a learned academy on Mauritius. The fortuitous conjunction of the unhappy scientists from the Baudin Expedition and some well-known local scientists, including two botanists—Aubert Dupetit-Thouars (1758–1831) and an old companion of Michaux's—led to the organization that year of the Société des Sciences et Arts de l'Isle de France. Bory was among the most enthusiastic and was the society's first secretary. Probably because the principals soon scattered again to the four winds, the society never left a published record and did not see the end of its second year (Ly-Tio-Fane 1962).

Meanwhile, the governor of Mauritius, a member of the new society, put Bory on his staff as an envoy to Réunion (then called Bourbon). Bory spent six months on Réunion and others of the Indian Ocean's Mascarene Islands. His spirited observations of their tropical habitats and volcanoes are still appreciated. Back on Mauritius, Bory studied its flora, fauna, and geology before departing in March 1802 on a neutral (German) vessel bound for France by way of St. Helena (Toussaint 1941; Bauchot, Daget, and Bauchot 1990).

Knowing that he would soon be required to reenter the army, Bory worked rapidly to publish some of his material. In 1802, he dedicated a small book to his uncle Bernard in support of the notion that the Azores were the lost continent of Atlantis (Agassiz 1848). A better-known work was the three volumes of text and one-volume atlas entitled *Voyage dans les quatre principales Iles des Mers d'Afrique,* published in Paris in 1804. Bory's four principal islands of the African seas were the Canary Islands and Mauritius in the track of the Baudin Expedition, and Réunion and St. Helena that he visited afterward.

Bory's book was not an official government report of the Baudin Expedition, despite some ambiguous wording on the title page. It came, however, just at the time that Péron and Lesueur were seeking support for continued government patronage. Therefore, in some circles, Bory's book was seen as an upstart's invasion usurping the areas of science that remained to be evaluated. Lesueur's influential father furiously threatened to publicly denounce Bory's book. I was pleased to see that Péron and Lesueur looked upon Bory's report as that from a colleague seeking only to summarize and spread knowledge. To them, Bory's book was to serve as a guide. It only touched on part of the cruise, and on none of Péron's or Lesueur's manuscripts, illustrations, or collections. In short, there was much not witnessed by Bory, and plenty for the other participants. Lesueur advised his father to be patient: "As you know, too much petulance spoils everything." Both Péron and Lesueur wrote to the senior Lesueur in October 1804 asking him not to say anything to anybody against Bory's book (Péron/Lesueur letters, Le Havre Museum). I was doubly pleased to learn that Bory and Lesueur, exact contemporaries, remained lifelong friends.

There had been a quasi-peace since the Treaty of Lunéville with Austria (in 1801) and the Treaty of Amiens with England (in 1802), but all bets were again off by mid-1803. So, as all good things must end, Bory took up with Napoleon's new "Grande Armée" in October 1803. In turn, he was on the staffs of Marshals Davout, Ney, and Soult, at the sharp end of war in nearly all of Napoleon's campaigns. Bory at first despaired that he would be killed and then, if he survived, that it would be with horrible wounds. A soldier needs good luck, and often, and Bory was blessed with the best of it. Although his mission was to prepare topographic maps in real time, he was not merely a quill driver, for this duty frequently placed him in harm's way. Napoleon's map makers were the finest in the world (Elting 1988). Surprisingly, war for Bory was not a monotonous horror; by luck or pluck, he found opportunities to wield his microscope seemingly as often as his saber (Castera 1987), most likely during the many periods of relative calm between Europe's ephemeral treaties and alliances. In 1808, again with Lacépède as sponsor, Bory was elected a corresponding member of the zoological section of the Academy of Sciences.

From 1809 to 1813, Bory was attached to Soult's headquarters in Andalusia (Spain). By 1812, he was a major (chef de bataillon), and in 1813 he received the Legion of Honor (Toussaint 1941). In 1813, Marshal Soult was sent as reinforcement for the coming and distant battle of Bautzen, three days of inconclusive carnage east of Dresden, Germany. In July, from Mainz, Bory wrote to a cousin (also a naturalist) that he was

> the kind of soldier who is today in the south, tomorrow in the north, and then reappearing in the south. You would not expect that my next trip would be to Bordeaux, and probably soon, even within the next dozen or fifteen days; I will be in Bordeaux and embrace you, as I return on the road to Spain.
>
> I was not able to spend enough time lately in Paris to be able to think about you, and I will not be able to this time either, not having but four days at most and Cuvier is to be absent. But I write you in advance in order to see if you can go to Spain with me with 25 Louis in your purse for your trip; this should take care of everything for some time, that is to say until my marshal can reinstate us a little. I will take care of your lodging and your meals, you will live with me and we will stick together. I promise you that you will take up the good life and be employed with natural history and even gather some ounces of gold (this is just between us). Please reflect on this; we will talk during the trip; it will be necessary to be prepared. (Castera 1987)

At least parts of war did not seem to be Hell, in spite of Napoleon's losing proposition in Spain.

Near the Spanish border at year's end, Bory wrote another letter to his cousin, who was then a curator at the National Museum in Bordeaux. After describing the battlefield destruction of men and horses around him, Bory said:

> My good fortune stays with me, and I have escaped from the greater dangers. . . . After such things, I am well convinced that I will never die in battle, but I confess to you that I do not desire peace any less. Our poor country is in the greatest need and I will go now to take up a position in the interior. (Castera 1987)

Jean Baptiste Bory de Saint Vincent (1778–1846). Courtesy of the Wellcome Institute Library, London; signature from letter to Lesueur, 28 September 1838, Letter 63100, Museum of Natural History, Le Havre.

By the beginning of 1814, Bory was a lieutenant colonel and an aide-de-camp. Napoleon's army, in spite of its legendary and deserved formidability, was not enough against all of Europe and treachery in Paris. Emperor Napoleon abdicated in April 1814, ending the Grand Army and, for Bory in particular, an intense way of life.

Bory's enthusiasm for things Napoleonic was not diminished, and when Napoleon rose again during the Hundred Days (March-June 1815), Bory was counted among his most ardent supporters. Elected a deputy, Bory was in Parliament as a fervent and very visible Bonapartiste. After Napoleon's most desperate battles and final fall, and with the Restoration, "Col. Bory" was outlawed and fled for his life (Bauchot, Daget, and Bauchot 1990). That momentous year of 1815 marked the virtual end of the eighteenth century, just as World War I effectively closed the nineteenth century.

Forced into exile by the law of 12 January 1816, Bory was on the run for the next four years. He found refuge mainly in Brussels (which was under the kingdom of the Netherlands from 1815 to 1830) and Berlin. In Brussels, Bory cofounded and edited the *Annales générales des Sciences physiques et naturelles,* which amounted to eight volumes between 1819 and 1821 (Agassiz 1848). Obviously, as an outlawed person, Bory did not receive his army pension and supported himself entirely with natural history publications.

Writing to his cousin from Brussels in early 1819, Bory admitted that he wanted to return to Paris but that he feared a trap (Castera 1987). All was forgiven in a general amnesty in December 1819, and Bory returned to France.

During much of the 1820s, Bory, as a "naturalist" with a Paris address, wrote for and edited the *Dictionnaire Classique de l'Histoire Naturelle,* which comprised seventeen volumes published from 1824 to 1830 (Agassiz 1848). In the ninth volume, in 1826, Bory included a four-page profile of the lernaeids, summarizing the recently published works of others. Among the contributors to this dictionary were Audouin and Lucas, yet to have their places in this narrative. On the back cover of Bosc and Desmarest (1830) is a printer's advertisement for a collection of similar *Manuels* that were to form a portable *Encyclopédie des Sciences et des Arts,* with Bory de Saint Vincent as one of the promised authors. Bory compiled a manual on reptiles for this series (Agassiz 1848).

Bory tried in vain to receive his half-pay pension from his long army service. Either because of real fiscal shortfalls or to declare a point, Bory did not pay his bills. Consequently, he was pursued by creditors and imprisoned as a debtor at Sainte Pélagie in 1825. The fact that Madame Roland had been held in this same prison a generation before probably gave Bory little comfort. Apparently and incredibly, Bory was in prison until 1828 (Bauchot, Daget, and Bauchot 1990). I would like to believe that he was under a kind of house arrest and that he could continue at least his reading and writing.

As usual, after a trying time, Bory landed on his feet again. In 1828, he was designated as the chief of the physical science section on an expedition sent by Charles X (king from 1824 to 1830) to explore Morea (the Peloponnesus Peninsula, Greece). Early in 1829, the expedition sailed from Toulon and, stopped by malaria, the participants returned at year's end.

The resulting publication, *Voyage Scientifique en Morée* from 1835, with the narrative by Bory, was critically and digressively reviewed in 1838 in the *Magazine of Zoology and Botany*:

> When it was determined to employ the combined arms of England and France in order to clear Greece of the remains of the barbaric race of Othman, the opportunity was not lost by the French government, and with the laudable zeal for science, which, amid the motley changes we have witnessed in these days, has never ceased to animate the various parties who have successively ruled at Paris, a sort of ambulant Institute, resembling on a smaller scale the celebrated body which accompanied the Egyptian expedition, was fitted out, with a view to explore the classic and almost unwrought soil their arms were called on to visit.
>
> The result of the labours of this commission has been recently made public. . . . Although we must in candour say that we have risen from the examination of it with a considerable feeling of disappointment, and that when we consider the means at the disposal of the commission, the time devoted to it, and the power they possessed of perambulating a region of comparatively small extent, and perfectly accessible at every point; as well as the vast advantage of visiting a country which, as far as natural history is concerned, . . . might be said to be unexplored, we felt entitled to expect that more might, and in fact ought to have been done;—nevertheless they have brought to light some very interesting facts, which we shall lay before our readers. . . .
>
> The work contains a sort of personal narrative of the parties engaged, a summary of the observations on mammalia, reptiles, insects, fishes, botany, geology, antiquities, statistics, and topography.[10]

The reviewer felt that the report was too political and anglophobic, and he proceeded to give some of this back to the commission. On the whole, the criticisms seemed contrived and may have even surfaced through a bit of international jealousy. The success of this endeavor led to Bory's admission to the Academy of Sciences in 1834 (Bauchot, Daget, and Bauchot 1990). In 1838 he was awarded the king's Legion of Honor.

Under Louis-Philippe (king from 1830 to 1848), Bory was designated to preside over the Scientific Commission for the Exploration of Algeria. Bory wrote to Lesueur on letterhead of the Ministry of War:

> My dear friend and old traveling companion with whom it has been some 38 years [since] I have voyaged. . . . I will tell you that it may be possible that I will make some voyage next year and that I would leave

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[10] *Magazine of Zoology and Botany* 2 (1838): 344–56.

> this winter. I would like to profit for the little time that I stay here to arrange my lichens and cryptogams. Are you able to have the utmost kindness to look into your packages to search for some lichens which I trust you have for me. . . . With luck, you may find some moments to trouble yourself for me. You have no idea of the pleasure that you have given me. In the hope of receiving from you this proof of friendship, I remain forever your sincere and old comrade. (MS letter, Bory de Saint Vincent to Lesueur, 28 September 1838, Le Havre Museum)

Lesueur had written to Desmarest outlining his efforts to collect lichens and cryptogams for Bory in the marshes around New Orleans, where Lesueur's companion Joseph Barabino contracted some illness (yellow fever?). They returned to New Harmony, where Barabino soon died (MS letter, Lesueur to Desmarest, 26 April 1834, Le Havre Museum; Bonnemains 1993).

The Algerian Commission successfully explored the French possessions in North Africa from 1840 to 1842, following their victorious armies. At the conclusion of the field work, Bory received the rank of colonel and presumably also his long-overdue retirement pay. During Bory's few remaining years, he worked primarily on the publications of the commission. Undermined by a heart condition, he spent his last days confined, working on his cryptogam collection and receiving friends. He died in Paris in December 1846.

Agassiz (1848) listed twenty-four zoological and geological publications by Bory. Among the wide-ranging papers was an 1825 essay on the zoology of man. Bory placed man in the same family as the anthropoid apes and admitted as many as fifteen species in the genus *Homo.* In other areas he showed similar insight, anticipating Darwin in speculations on paleo-oceans and oceanic islands. Bory's library of natural history, voyages, general history, and literature was auctioned on 20 March 1847, "precisely at noon," from a printed list of twenty pages.[11]

Jean Victor Audouin

27 April 1797–9 November 1841

Jean Victor Audouin (1797–1841). From Bonnet (1945); signature from Theodorides (1968).

Audouin is another zoological pathfinder who has so much to recommend him that he cannot be portrayed in any simple fashion. Perhaps Audouin is best remembered as an entomologist, and like so many other contemporary entomologists, he crossed over at times to crustaceans. Audouin's excursions into crustaceans were not merely incidental; however, his admission into our company was attained by a single paper on a single copepod. Audouin's achievements with crustaceans and marine science were in conjunction with his friend and colleague Henri Milne Edwards, a bright name already mentioned; Milne Edwards will reenter and prevail in our narrative for a good part of the nineteenth century.

Jean Victor Audouin was born in Paris and destined by his family to a career in law or medicine. He did study medicine, obtaining his M.D. in 1826, but he found the immense and untouched fields of natural history, and especially zoology, irresistible. Audouin was a student of Cuvier and Geoffroy St. Hilaire, and he assisted both Lamarck and Latreille at the Museum of Natural History. It is not surprising that his first published works, from 1818, dealt

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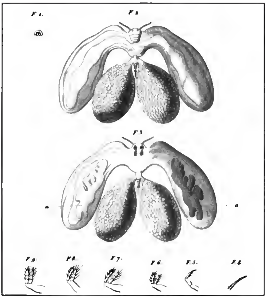
[11] Listed in and quoted from the Harvard University Library catalog.



A copepod, Nicothoe astaci, *parasitic on lobsters. From Audouin and Milne Edwards (1826).*

EXPLICATION DE LA PLANCHE XLIX.

Fig. 1. Nicothoé du homard, de grandeur naturelle.

Fig. 2. Le même individu, très-grossi et vu en dessus.

On aperçoit les antennes, les quatre segmens du thorax; le premier supporte une paire d'yeux. On voit les deux prolongemens latéraux antérieurs qui sont doublés par une tunique membraneuse, laquelle renferme deux cœcums qui se réunissent sur la ligne moyenne du corps. Les deux autres prolongemens sont les sacs remplis d'œufs et attachés à l'abdomen, qui a cinq anneaux, dont le dernier est terminé par deux longs filets.

Fig. 3. Le même individu en dessous pour faire voir, 1°. l'insertion des antennes au-dessous du premier anneau du thorax; 2°. les pattes rangées sur deux lignes: les trois paires antérieures sont dirigées en avant, et les deux paires postérieures le sont en arrière; 3°. deux masses, *aa*, découpées sur leurs bords, et qu'on peut supposer être les ovaires internes.

Fig. 4. Antenne excessivement grossie.

Fig. 5. Première patte. — Fig. 6. Deuxième patte. — Fig. 7. Troisième patte. — Fig. 8. Quatrième patte. — Fig. 9. Cinquième patte.

Ces pattes, de même que l'antenne, sont représentées dans une proportion beaucoup plus forte que les figures 2 et 3.

with insects, in particular with the anatomy and physiology of insect reproduction (Milne Edwards 1841).

In 1824, Audouin and two colleagues (with whom he would later be related by marriage) founded the *Annales des Sciences Naturelles* (Bonnet 1945; Theodorides 1968, 1978). Audouin was a lifelong editor for the *Annales.* The pages of this journal preserve the records of numerous Audouin studies on annelids, ascidians, crustaceans, mollusks, and zoophytes.

Audouin and Milne Edwards recognized that there was no synthesis of French-coast marine animals, particularly marine invertebrates. To fill what they saw as an obvious void, they visited the Brittany and Normandy coasts in 1826, the first of three similar excursions. Their main interest was in the invertebrates of the seashore, and in this the two men pioneered in a great undertaking. Their methodical work led to the two-volume "Research on the Natural History of the French Shores," published in 1832 and 1834. Hedgpeth (1957) recognized in this "the unmistakable beginnings of modern marine ecology."

In 1827, Audouin married Mathilde Brongniart, the youngest daughter of the geologist Alexandre Brongniart (1770–1847). Mathilde's brother, Adolphe Theodore Brongniart (1801–1876), was a botanist and cofounder of the *Annales.* In 1826, Audouin and Milne Edwards had noticed the zoological potential of the Chausey Islands and decided to return at a later time. This was fulfilled in 1828, when the two brought their spouses on what must have been one of the most idyllic naturalist ventures of all time. Nearly everything examined on these scarcely inhabited islands was new or little known. Although this was their native land, it was as exciting as the most exotic place. Their wives assisted by drawing organisms as observed through the microscope. An aquarium was constructed to maintain water flow so that the habits and development of live animals could be seen. Many of Audouin's notes and drawings have survived from this time, bearing witness to his enthusiasm for the "numerous animals of our little menagerie" (Theodorides 1968, 1978). A preliminary list of invertebrates from the Chausey Islands was published in 1828.

The third voyage, to the Brittany coast, was in 1829. The surveys by Audouin and Milne Edwards were of modern precision and outlined the horizontal and vertical distribution of marine invertebrates. Their scheme of zonation with depth, naming five zones for the dominant littoral organisms, persisted in the growing ecological literature for fifty years (Hedgpeth 1957).

Along with their general appraisal of the geology and zoology of the Channel coast, Audouin and Milne Edwards collaborated on detailed studies of the anatomy and physiology of crustaceans. Their publications on the circulation and nervous systems of crabs and lobsters were extraordinary, and they won a prize from the Academy of Sciences for experimental physiology (Berthelot 1894). The authors continued their physiological series with a publication showing the modifications of the decapod branchial system with geographic distribution, comparing the unequal species fitness (especially with respect to temperature) with the presumed centers of creation.

Among the first of Audouin's papers on crustaceans was the 1826 report, with Milne Edwards, of the strange new copepod *Nicothoe astaci,* parasitic on the gills of lobsters taken at Granville during the last days of September. The paper was presented to the Academy of Sciences at its meeting in November and published in December. The authors believed that this was a crustacean, and that, by analogy, the puzzling lernaeid parasites must also be crustaceans (Baird 1850). (Today, this copepod is the basis of the family Nicothoidae, near the siphonostome family Choniostomatidae, with many other parasites of crustaceans.)

Audouin and Milne Edwards (1826) noted the extraordinary lateral expansion of the body of *Nicothoe* and clearly related it to Müller's *Cyclops.* They gave a very detailed account and compared the new form to several other parasitic genera, such as *Anthosoma, Cecrops,* and the "Dichelestions of Hermann fils," as well as to Jurine's *Monoculus* that they referred to *Cyclops.* Following Latreille's 1817 classification, *Nicothoe* was placed in the Poecilopes section of Branchiopodes.

Audouin and Milne Edwards thought that *Nicothoe* was incapable of locomotion; they were therefore puzzled over its reproduction and wondered if it was hermaphroditic. They mentioned Suriray's report, as referenced by de Blainville, describing the newly hatched free-swimming lernaeids that resembled "Crustacés monocles," while the mature form was monstrous and immobile. They concluded that this point had not received the attention it merited, but that it indicated to them that the lernaeids were crustaceans. Audouin and Milne Edwards recognized this as a great leap, which remained for them provisional and subject to more study of lernaeid life-history and anatomy. They were too generous when they said that Cuvier and de Blainville had anticipated this situation.

Audouin was one of the founders of the Entomological Society of France in 1832. At Latreille's death in 1833, Audouin replaced him "without contest" as Professor of Entomology at the Museum (Milne Edwards 1841). In this capacity, he devoted much effort to the entomological collection (which included crustaceans and arachnids as well), as Latreille had before him. Certainly, many new specimens arrived at the museum through the field work of Audouin and Milne Edwards. Audouin was an Honorary Fellow of the Entomological Society of London from its founding in 1833 (Neave 1933).

We have been left with a brief personal look at Audouin through an account of Michael Sars. Sars had been invited to Milne Edwards's home for dinner in July 1837. There he met other professors and their wives, and a brother of Milne Edwards:

> All were mostly in black clothes, the professors with a little red ribbon in their buttonhole, which was a mark of distinction. Audouin is a somewhat paunchy man with a narrow expressive face; an excellent observer; I asked him, whether or not he would continue their interesting work on the French coast; he said that he now has other pressures because he was so far behind on the studies of the habits and habitats and metamorphoses of insects, which take up all his time. (M. Sars MS, qtd. in Økland 1955)

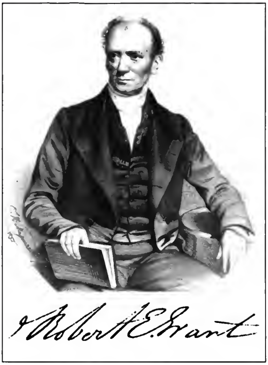
In spite of their earliest ambitions to outline the invertebrates of the entire French coast, by the mid-1830s Audouin and Milne Edwards, as a team, had concluded their contributions in this field.

Agassiz (1848) recorded more than a hundred Audouin publications. A series of papers on insects injurious to agriculture gained Audouin entry into the Academy of Sciences in 1838 (Milne Edwards 1841). Audouin was a corresponding member of the New York Lyceum of Natural History and the Academy of Natural Sciences of Philadelphia. In 1841, "in the vigor of his age," death claimed Audouin. His "dearest friend and most devoted collaborator," together with the president of the Academy of Sciences and the directors of the Museum of Natural History and the Royal Society of Agriculture,

> transcribed the sentiments of regret expressed at the side of his tomb by his colleagues and his friends. . . . But here the voice of the heart also must be heard, and a close friendship which dates from more than 20 years and which had not given way one instant, has imposed upon me the sad duty of my speech; because, it is not only as a scholar that our colleague is deserving of our regrets: his moral virtues were not less remarkable than the faculties of his spirit, and our long intimacy allowed me to learn the qualities of his soul, better perhaps than any other person outside of his family. (Milne Edwards 1841)

The French tradition of filling professorships only when death declares an opening was especially apt

Robert Edmund Grant (1793–1874). Courtesy of the National Library of Medicine.



Robert Edmund Grant, in 1852. Courtesy of the Wellcome Institute Library, London.

for Audouin's position. No more appropriate candidate than Milne Edwards could have been found to be the new professor at the museum, and he served science and his country well for more than forty additional years (Forest 1996).

Robert Edmund Grant

11 November 1793–23 August 1874

It is likely that I long ago encountered a biography of Robert Edmund Grant but disregarded it in the ignorance of his link to lernaeids. This important Scottish zoologist was the first to show both the true nature of sponges and that they were not coelenterates: "The morphology and physiology of sponges were first adequately understood by R. E. Grant, beginning in 1825, who created for the group in 1836 the name Porifera . . . , by which it is now generally known" (Hyman 1940).

Grant was born in Edinburgh, a seventh son, and long tutored at home. After high school at Edinburgh, he entered the university and received an M.D. in 1814 with a dissertation on blood circulation in the fetus. He then went to Paris and attended lectures at the Jardin des Plantes in 1815–1816. He traveled for the next five years in France, Italy, and Germany (Desmond 1984). He then returned to Edinburgh and lectured on comparative anatomy. He also taught Darwin about microscope technique. Darwin recorded that Grant had "much enthusiasm beneath [a stuffy] outer crust" (Desmond 1982).

In 1827, Grant moved to London as the first Professor of Zoology at the new University College. London was then the most populous city in the Western world and would soon, as the center of a vast industrial empire, see the long and prosperous reign of Queen Victoria. In the Grant years, London witnessed profound scientific, technological, and social transformations.

Grant was one of those pre-Darwinian biologists who very nearly grasped the nettle. In fact, Huxley, Darwin's champion, said that Grant was the only one he knew who really taught evolution before Darwin. Not surprisingly, Grant was excoriated in some circles for his views. There were abiding antagonisms between the transmutationists on the one side and those, such as Richard Owen, who believed in the immutability of species, in metaphysics, and in natural philosophies. Grant lectured as a transmutationist, with its whiffs of spontaneous generation, godless accidental development, mechanisms, and atheisms. Although Grant's beliefs were also held by many religious biologists, his early and conspicuous stand brought him unenviable criticism and much stress, especially as Owen's arch rival. Copepods were not brought into this battle, and fighting it to a conclusion was left mostly to the paleontologists and proponents of the charismatic megafauna (Desmond 1982).

Grant assumed that nature responded to laws, but not the laws of a divine being. To this end, life did not have a providential "design," a familiar and popular contemporary theme. By the 1830s, Grant, personally acquainted with Cuvier, Geoffroy, and Lamarck, gave the most advanced courses in comparative anatomy in Great Britain.

Grant's (1827) contribution to copepod studies was but a single paper. The title page announced that Grant was a Fellow of the Royal Society of Edinburgh and a Fellow of the Royal College of Physicians of Edinburgh. In 1827, he was "formerly Lecturer on Comparative Anatomy." Grant was also a member of the Entomological Society of London from its third year, 1835 (Neave 1933).

Nordmann (1832) and Brian (1906) said that Grant's short contribution contained the best and most complete description of a *Lernaea* up to 1832. It remains a pity that copepodologists heard nothing further from R. E. Grant. After a review of the universal habit of parasitism, Grant prepared the reader for his assessment of a lernaeid's place in the animal world:

> Although most parasitic worms live entirely imbedded in the animals on which they feed, the remarkable tribe of *epizoariae* to which the *Lernaea* belongs, are found only attached to the surface, or partly buried in the superficial soft parts of marine and freshwater fishes, while the rest of their body hangs constantly exposed to the action of the external element. (Grant 1827)

From this dual nature, Grant said, they derive characteristics of both intestinal worms and insects, pointing out from de Blainville (1822a) that they have rudimentary antennae and sessile eyes:

> These affinities with the higher classes of invertebrate animals . . . which have greatly perplexed other naturalists in their classification, are well exemplified in the *Lernaea elongata*, particularly in the perfect symmetry . . . , the distinctness and firm texture of the head, in the rudimentary antennae and appendices of the mouth, and in the regular form of the body and two ovaries. (Grant 1827)

We have already observed how Grant received his specimen from Scoresby and Brewster, "who has kindly favoured me with the larger of the two specimens, nearly three inches long, and probably the largest *Lernaea* hitherto met with" (Grant 1827). Grant's description was exceptionally long and thorough, and complemented by a good drawing of the copepod adhering to the outer surface of the transparent cornea of the shark.

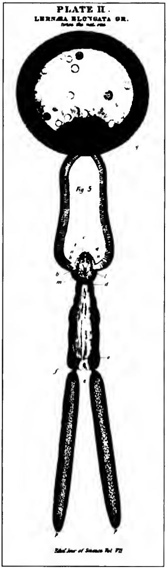
Although de Blainville would have us believe that he had clearly resolved the crustacean affinity of lernaeids, his work was no stimulus to Grant in this regard. The closest Grant came to considering crustaceans in the same breath was the observation that his lernaeid possessed a horny hook "like the pincers and inner jaws of a crab," and that within its head was a "white pulpy matter like the ganglion . . . in crabs" (Grant 1827). The digestive gland was also reminiscent of that in crustaceans and mollusks.

Grant noted that both he and de Blainville failed to see a circulatory system in their lernaeids:

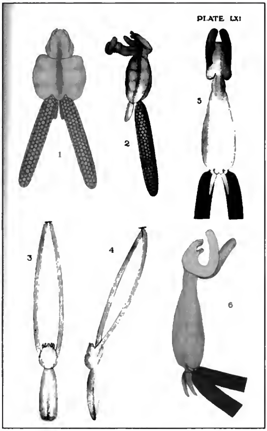
> It was carefully dissected, under pure water, and examined with the aid of lenses. . . . The absence of a circulatory system would remove the *Lernaeae* to a place much below the class of molluscous animals, in which Linnaeus, Bruguieres, Ocken, and many other naturalists have placed this genus. (Grant 1827)

The other specimen, that kept by Brewster, was without egg sacs, but Grant thought that these had been lost in the handling; therefore, he acknowledged no information on the possibility of separate sexes. Since Scoresby recorded egg sacs as a constant occurrence, Grant believed that considering "the fixed life of the *Lernaea*," each individual was both female and male. However, "the internal structure, and the mode of generation of *Lernaea*, and even the place which they occupy in the scale of animals, are still undetermined" (Grant 1827). In spite of de Blainville, and some retrograde notions of his own, Grant seems to have been content in leaving lernaeids in Lamarck's separate class, Epizoaria.

Grant summarized that "many species of this animal have been described and figured by Müller, Linnaeus, Bosc, Bruguieres, Ocken, Lamarck,



A copepod, Lernaea elongata, *parasitic on the Arctic sleeper shark. From Grant (1827).*



Lernaeopoda bidiscalis *Kane, 1892 (Figs. 1–2),* L. elongata *(Grant, 1827) (Figs. 3–4), and* L. similis *Scott & Scott, 1913 (Figs. 5–6). From Scott and Scott (1913).*

Lesueur, and Blainville, but the species above described appears to have escaped their notice" (Grant 1827). Indeed it had, and this Scoresby/Brewster/Grant species comes down to us today as *Ommatokoita elongata* (Grant, 1827), a lernaeopodid siphonostome. This Leigh-Sharpe genus from a century later is characterized by the second maxillae forming an "anchor chain" to the shark's eye, a feature well shown by Grant (see Kabata 1979).

Ommatokoita elongata is common on the corneas of the Greenland shark, as Scoresby said it was. The vast majority of these sharks have been reported to have the parasite on both eyes, and only 1 percent are free of it (Kabata 1979). As for this unwanted attachment leaving the shark blind, recent research has revealed gross injury to the shark's eyes (Caloyianis 1998). The indifferent behavior noted by Scoresby was also known by those who earlier described this shark's genus, *Somniosus,* "the sleeper."

Agassiz (1853) tabulated thirty-one other Grant publications; most of these are anatomical and physiological contributions. The greater number deal with sponges, mollusks, and zoophytes, but they include other animal groups as well. In 1835, Grant published in London a several-part, several-hundred-page *Outline of Comparative Anatomy*; this had other editions, including one translated and published in Germany. A reviewer in the *Magazine of Natural History* from 1835 said that "every student of natural history should possess himself of the contents of the entire work." By this time, "Professor Grant" was well known to naturalists outside of Scotland in his new position at University College London (Johnston 1847, Mitchell 1929, Gunther 1980).

Before this time in England, government had taken little interest in the work of its greatest museum, in contrast to the celebrated situation in France. This was beginning to change, a slow response to worldwide transformations symbolizing the nineteenth century, coming after the great events of 1815 that clearly marked a separation from the eighteenth century. In 1835–1836, several London scientists were asked to testify for a Parliamentary Committee on Natural History investigating the condition and management of the British Museum.

Gunther (1980) referred to "the outspoken opinions of Professor Grant" against the practice of appointing men of "rank, wealth and high station," without regard to scientific capabilities, to the museum's board of trustees:

> I should not think, from any knowledge that I have ever obtained of the scientific requirements of these noblemen and gentlemen, that they were the most competent men in Britain to regulate the affairs of such an institution. . . . Anything would be better than the present system at the Museum. (Grant, qtd. in Gunther 1980)

Regarding the arrangements and state of the collections:

> I conceive that, compared with the corresponding institutions of our Continental brethren, the zoological collection of our National Museum, and the management of that collection, are an opprobrium to the British nation and these enlightened times. (Grant, qtd. in Gunther 1980)

Testimony like Grant's enhanced the concept of a national museum in England. It also improved the abilities of the museum to encompass research and education, in addition to collecting. For zoology, a major step was the removal of that element from the administration by mineralogy, which had been done years before with botany. The result was improved staffing in a three-branch natural history institution: mineralogy, botany, and zoology.

Grant's last years were sad and overwhelmed with financial problems. The university refused to make Grant's lectures mandatory for the medical curriculum, and his salary, based on number of students, was pitifully low. When Grant died in August 1874, his professorship fell to Edwin Ray Lankester (1847–1929). I was glad to note, in fitting testimony to Grant's critical research on sponges, that he is memorialized in the sponge genus *Grantia* and several derivatives.

Jean Louis Florent Polydore Roux

31 July 1792–12 April 1833

The world had only a brief encounter with Jean Louis Florent Polydore Roux, and copepodology even a shorter acquaintance. What I know of him is mainly from his colleague and successor Barthélemy (1833, 1834).

Roux was born in Marseille and, as a youth, enjoyed looking at zoological publications. He was gifted with a fertile and brilliant imagination. His advanced studies were in Paris, where he was a student of Latreille and Cuvier. Before 1814, Roux had formed an impressive entomological collection; the renewed postwar commerce with the New World enabled him to double his collection within a few more years.

In 1819, Roux was named curator of the natural history cabinet at the museum in Marseille. His attention now broadened to specimens from the beaches, and with local support he obtained collections of shells and minerals from notable naturalists. Roux corresponded with Risso about fish and crustacean collections from 1825 to July 1831 (Monod and Hureau 1977). In 1826, Risso named a parasitic copepod after Roux, *Pandarus rouxi.* Roux greatly admired Risso and expressed gratitude for his frequent and close counsel although, at least until September 1828, they had not met. Roux's zeal and discrimination also enabled him to add fine specimens of birds, mammals, reptiles, fish, and crustaceans through worldwide contacts.

The local administration in Marseille encouraged research on local natural history, to which Roux was devoted. This project eventually encompassed introduced species as well as industrial products of the region. Into the 1830s, Roux proposed construction of an inclusive natural history and art museum, but he was opposed by the university at Marseille. Discouraged by overwhelming administration, he sought happier objectives and some solitude. Again with local support, and Cuvier's blessing, Roux proposed an exploration into the interior of Africa. He wrote to Risso on 1 July 1831 describing his plans, which included ventures into America (Monod and Hureau 1977). Roux left France in September 1831, accompanied by a friend, Baron Karl von Hugel (1795–1870), an Austrian explorer and naturalist.

The intrepid pair went first to Alexandria and, under the most auspicious circumstances, began their venture. During the next four months, they explored lower and upper Egypt, Nubia, and part of Arabia along the Red Sea. Of greatest interest were the diverse birds, fish, shells, crustaceans, mammals, insects, and reptiles.

Apparently, the duo had intended to go next to some Mediterranean islands but chose India instead. Perhaps they did not wish to backtrack along their overland course. In contrast to the lighthearted and rewarding African phase, everything went wrong in India: "To us, this second period of the voyage is still enveloped in a mystery which time without doubt will illuminate, a period of regret and grief for science as well as for the ties of blood and friendship" (Barthélemy 1834). In India, the previous "most perfect harmony between the two voyagers" broke down, leading indirectly to Roux's death from exhaustion in 1833.[12]

Roux possessed to a high degree many qualities of a successful naturalist-explorer. He was robust with a strong, constant, and determined character. He was a good writer and illustrator, but he was too optimistic when he wrote from Egypt:

> Wandering all day, with my shotgun on my shoulder, my portfolio under my arm, . . . I am pleased to meditate upon the past splendor of a people on whose bones I tread; but the recollections of my country are for me distractions; and my mother and my friends occupy my thoughts. That I dream about you, you can have no doubt. I have enjoyed good health up to now, and the prudence which accompanies all my actions is for me a sure guarantee. (Roux, qtd. in Barthélemy 1834)

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[12] A survey of Hugel's narratives of his travels in Panjab and Kashmir revealed a portrait of a self-satisfied and conceited-looking man, as well as lengthy self-serving texts, but not one word about Roux.

Roux was an active member or correspondent of several French and foreign scientific societies. Agassiz (1854) listed nine Roux publications. Roux published a plea in 1831 for an enlarged public natural history cabinet in Marseille. He also contributed an ornithology of Provence, in southeastern France, with fifty-six plates, and he published a multipart memoir on the crustaceans of the Mediterranean shores in the *Annales des Sciences Naturelles.* Roux left unfinished several planned works on fish and shells of the Mediterranean.

Roux's series on crustaceans was published separately in Paris in 1828 as the "Crustacea of the Mediterranean and its Shores," with forty-five plates. He included two species of parasitic copepods, with "a good plate of *Nemesis lamna* Risso, not to be passed over" (Brian 1906), and a new species, *Nemesis carchariarum,* now considered a synonym of the former.

Polydore Roux was

> a naturalist distinguished by the breadth of his knowledge, but he also deserved to be appreciated for his pleasing qualities of the heart and of the spirit; still very young, his career was prematurely ended far from his country, his parents, and his friends. (Barthélemy 1834)

Adolph Wilhelm Otto

3 August 1786–14 January 1845

Adolph Wilhelm Otto was Professor of Human and Comparative Anatomy at the University of Breslau (Gunther 1975). Breslau appeared in our narrative very early: the quasi-medieval crustacean book by Sachs (1665) was published there when the old name of Wratislava was in vogue. This became the Prussian/German town of Breslau in 1741 and remained so until after World War II. It is now Wrocław, Poland. Thus, in Otto's time, it was under German government control.

Otto was born in Greifswald. He studied medicine first in Frankfurt and then Greifswald, under the direction of an uncle, a high-ranking physician (*archiater*). In Greifswald, Otto successfully defended his 1808 dissertation on the anatomy of cranial deformities. In 1809, he went to Frankfurt to obtain the certificates to practice medicine. He stayed there as an anatomical demonstrator and assistant physician at a clinic (Hirsch 1887).

In 1811, Otto attained the status of Privatdocent at the Faculty of Medicine in Frankfurt with a dissertation on human structural abnormalities, and he was soon also named Professor Extraordinarius. Otto then undertook broad scientific travel through Germany, the Netherlands, and France. In Paris, he studied comparative anatomy under Cuvier's direction. The University of Frankfurt was transferred to Breslau in 1813, and Otto was called there to be Professor Ordinarius of Anatomy and director of the anatomical museum. In 1821, he was named as a medical officer to the Board of Health, and also a member of the medical college.

In spite of his weakened health, Otto prevailed with uncommon faithfulness in the numerous duties arising from his official and academic positions. Frequent recreational trips and a happy domestic situation helped sustain him. He gradually lessened his significant physical burdens in 1844 when he experienced symptoms of a serious liver ailment, from which he died in January 1845 (Hirsch 1887).

Otto followed the early champions of pathological anatomy and brought this field to a high point in Germany. However, he left unexamined the combinations of pure descriptive anatomy with physiological and embryological questions that were just being raised. Likewise, in the last decade of his life, the application of microscopes for histological investigations was not realized. Still, for his time Otto's work was fruitful and his contemporaries found it to be exemplary.

Otto responded well to the academic challenges of anatomical studies. He instigated a new anatomical theater in 1834–1835. He also brought to completion the distinguished anatomical museum, still a credit to Wrocław's scientific institute. Otto was made Confidential Medical Councillor in 1836, and later was inducted into the Order of the Red Eagle, a high honor that he is wearing in the accompanying portrait. In the years 1838–1839, Otto was the university's Rector Magnificus, its highest position.[13]

Michael Sars, the peripatetic copepodologist-to-be, left us a brief glimpse of Otto at an 1837 meeting of naturalists in Prague. After leaving France, and several of our copepod-colleagues, Sars intended to travel to Berlin but was dissuaded because of a serious cholera epidemic there. He chose Prague instead, lured by the prospect of a large mid-September gathering of naturalists:

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[13] With the position of Ordinary Professor, a man was also on the academic senate, advising and deciding on the most important matters in the university. At the head of each faculty was a dean, and at the head of the university was a rector, both selected annually (Brockhaus 1895).

> I arose early and prepared to meet with Prof. Otto from Breslau, and also with a son of [Carl Gustav Carus (1789–1869), German zoologist], who studies in Leipzig. Otto and Carus had heard of my discoveries and now wished to make my acquaintance. Otto is a good-natured man, looking somewhat feeble, but has an interesting expressive face. I was able to show him the most important of my drawings, which greatly pleased him. He promised further exchanges so that he could inform me of his activities in the Mediterranean. In the afternoon I called on Carus to see specimens under his excellent microscope. (M. Sars MS, qtd. in Økland 1955)

On 18 September, the naturalists filled the great hall of the Carolinum. Sars said that there were between four and five hundred participants and wives. One of the first general lecturers was Baron Hugel, with a well-received presentation on his trip to the Orient, India, and New Holland.[14]

The following day, the meeting broke into sections, a custom not so new as one might believe. Sars attended the zoology proceedings. At midday, he ate with many other naturalists at a restaurant where discussions continued. Otto was among those with whom Sars was already acquainted. A large company, including Otto and Sars, was invited to an informal post-meeting at the home of a local professor. Sars had been asked to bring his drawings, which were then discussed. Sars related a hearty gathering, with wine and champagne; it was after midnight when he left.

Sars again attended the zoology section on the following day, listening to lectures by Otto, Tilesius, and others. He took time out to peruse the zoological collection in the Jesuit College, a large building in the old town where some of the lectures were given. Lunch that day was at the same restaurant, this time with music. The day ended with a grand dinner at the governor's castle, with a brilliant concert by the Prague Conservatory of Music.

The last day again afforded lectures by Otto and colleagues. Sars was able to compare notes on selected invertebrates with other attendees, and he toured art galleries in the afternoon. He left the next day for his long trip home (Økland 1955).

Adolph Wilhelm Otto (1786–1845). Courtesy of Z. Jara, from the Archives of the University of Wrocław.

Agassiz (1854) recorded nineteen publications by Otto. Most of these were anatomical and physiological, but two considered crustaceans, and both included copepods. The first, from 1821, was "a preliminary review of some marine animals not yet described," a twenty-page tract published at the university, under the old town name of Wratislava. Two new species of copepods were described in text: *Caligus heptapus*[15] and *Caligus minimus* Otto, 1821 (see Margolis, Kabata, and Parker 1975). Both species were from Nice, collected in 1818 or 1819.

Otto (1828) redescribed both copepods in a nicely illustrated and concise report on nine crustaceans. The detailed and colored plates were signed by Otto, and he listed himself on the title page as "Dr. A. W. Otto, Member of the Academy." The academy, the revered Academiae Caesareae Leopoldino-Carolinae Naturae Curiosorum, was the publisher. Otto's descriptions were far better than the typical portrayals of his time. Each species was described first in Latin, and, except for one copepod, followed by a longer description in German. Two crabs (both from Naples), three shrimp (two from Nice, one from Naples), two isopods (both from Nice), and the two earlier copepods were described.

Otto (1828) more or less followed the 1817 classification of Latreille by placing his two copepods in the Order Branchiopoda, Family Poecilopoda. Strangely, Otto renamed the *Caligus heptapus* of 1821 as *Caligus paradoxus* new species. This is clearly an objective synonym of the former, and the two species are therefore identical (Kabata 1979). Otto described and illustrated both sexes of this "pale, yellow-brown" species:

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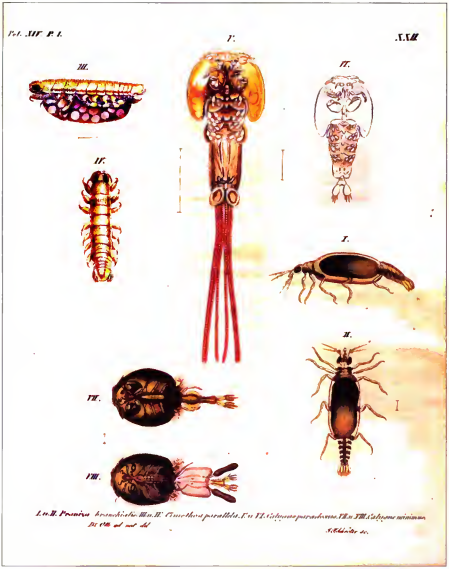
[14] I would have liked to ask him what happened to Roux.

[15] Now *Demoleus heptapus* (Otto, 1821), in a genus formed by Heller in 1865.

> I found several specimens of this, which if I am not mistaken, new fish-louse at Nice upon the fins of a *Squalus griseus* [shark]; the figures are given in an enlarged scale, with Fig. V the female and Fig. VI the male; the adjacent lines give the natural size of the animals, as indicated by the largest specimen. (Otto 1828)



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I. u. II. Praniza branchialis. III. u. IV. Cymothoa parallela. V. u VI. Caligus paradoxus. VII. u VIII. Caligus minimus.
Dr Otto ad nat. del.
J. Schröter sc.

Caligus paradoxus *(Figs. V–VI) and* C. minimus *(Figs. VII–VIII). From Otto (1828).*

The second species, *Caligus minimus,* was also termed a new species, but it is the same as Otto's valid species from 1821. Only the Latin text was provided, together with figures of both sexes: "I found six specimens of this species of fish-louse, whose figures make superfluous a further description, on the palates of *Perca labrax* at Nice" (Otto 1828).

Otto (1828) referred to Risso (1816), and the two men corresponded (Monod and Hureau 1977), so it is most likely that they were personally acquainted.

Anders Adolf Retzius

13 October 1796–18 April 1860

Anders Adolf Retzius is another admitted to our copepodologist congregation by a single article, but whose overall contribution to science ensured that he would be well remembered in other fields. He was a pioneer of comparative anatomy in Sweden, especially as it pertained to medical studies. He placed anthropology on an anatomical foundation. To Nordenskiold (1928), he was the "foremost Swedish biologist of his period."

Retzius was born in Lund, Sweden. His earliest zoological studies were under his father, Anders Johan Retzius (1742–1821), one of Linnaeus's students and a well-known anatomist and anthropologist. Retzius's own son, Gustaf Magnus Retzius (1842–1919), another anatomist and anthropologist, capped a working scientific dynasty that extended over a century and a half (*Webster's* 1960).

Retzius spent the year 1816 at the University of Copenhagen, studying chiefly under the surgeon/anatomist Ludvig Jacobson (1783–1843), a friend of Cuvier, de Blainville, and Michael Sars. Retzius also was influenced by the zoologist Johan Reinhardt, a major force in the development of Krøyer and Steenstrup, yet to be acknowledged in this narrative. Retzius returned to Sweden and obtained an M.D. from the University of Lund in 1819. His dissertation, dedicated to Professor Jacobson, was on the anatomy of sharks and rays (Lennmalm 1908, Larsell 1924, Økland 1955, Wolff 1979).

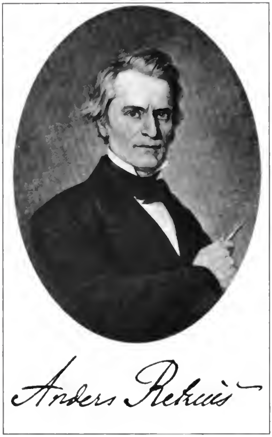
During the previous year, 1818, Retzius had joined the veterinary staff of the Royal Military Academy at Carlburg. He also accepted the care of his father, who had been half-paralyzed that year by stroke. In 1820, Retzius moved to Stockholm and joined the Veterinary Institute. In 1823, he was named Professor of Veterinary Science (Lennmalm 1908).

Retzius so impressed the founders of the Caroline Institute of Medicine and Surgery that in 1824 he was given a position there, as Professor of Anatomy, in addition to his primary service at the Veterinary Institute.[16] Retzius held both positions until 1840, when he went over completely to the Caroline (Larsell 1924).

Retzius's research was many-sided, perhaps even with a restless aspect. Agassiz (1854) provided a partial list of twenty-one fact-filled zoological papers. One of Retzius's most significant contributions was on the morphology of hagfishes in 1822–1824.[17] Hagfish, like lernaeids, wandered in the taxonomic wilderness, through worms, mollusks, and amphibians. It was not until Retzius's work, and later with that of his friend Johannes Müller, that these strange creatures were seen to be primitive fish (Nordenskiold 1928).

In 1832, when cholera first reached Sweden, Retzius reported on its course through the country and on his observations of its progression in individuals (Lennmalm 1908). After 1839, Retzius suffered eye problems, which prevented research into fine details. He then embraced comparative anthropology, applying anatomy to the pioneering studies of Johann Blumenbach (1752–1840).[18]

Retzius visited many western European museums, laboratories, and universities, and was well known to a host of scientists. In 1828, at a naturalist's conference in Berlin, Retzius met Johannes Müller, a bulwark of German physiology.[19] Next to his pupil-friend Jakob Henle (1809–1885), "Retzius was the one person to whom the reserved Müller opened his heart to lasting friendship" (Koller 1958). Müller traveled with Retzius to the Swedish coast in 1841 to study amphioxus, another primitive vertebrate. During their cooperative work afterward in Stockholm, Retzius took Müller for an hour's audience with the Swedish crown prince. On his return to Germany, Müller wrote that



Anders Retzius

Anders Adolf Retzius (1796–1860). From Lundborg and Runnstrom (1921); signature from Lennmalm (1908).

> I have no friend whom I esteem as much as you [intimate form, Du]. First of all, a thousand thanks for all your kindnesses that you have shown to me, and that are to me unforgettable. . . . Greet all of the dear friends and acquaintances in Stockholm, especially your dear wife and family. Please convey to your wife once again my heartfelt thanks, and to you, my dear friend, let me repay by true friendship and loyalty, every kindness you have given me. (Koller 1958)

In 1855, Müller added that Retzius was "my oldest, dearest friend" (Koller 1958).

In 1833, Retzius toured Europe in conjunction with a Congress of Naturalists meeting in Breslau. There he met Johannes Purkinje (1787–1869), Czech physiologist, inventor of the term "protoplasm,"

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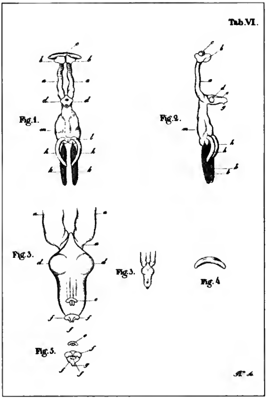
[16] The Caroline was founded in 1810; still with a world-class faculty, it nominates the Nobel Prize winners in medicine.

[17] Agassiz (1854) also listed fourteen papers by the elder Retzius, including one on hagfish in 1790.

[18] Blumenbach, coiner of racial categories like "Caucasian," was for sixty years professor at the University of Göttingen, in Germany; von Siebold and Leuckart, famous copepodologists yet to be introduced in this narrative, were, respectively, direct and indirect Blumenbach students.

[19] Some of Müller's students will loom large in our narrative.



A copepod, Lernaea dalmanni, *parasitic on a North Sea ray. From Retzius (1830).*

and professor at Breslau and Prague. Purkinje tutored Retzius on microscopical and histological technique (Nordenskiold 1928).

Retzius was also friends with the copepodologists Michael Sars and Sven Lovén, who will soon have their place in this narrative (Økland 1955, Koller 1958). Other Retzius friends included the German anatomist and physiologist Rudolf Wagner (1805–1864), a link between Cuvier and Leuckart, and the Estonian naturalist Karl Ernst von Baer (1792–1876), pioneer embryologist and discoverer of the human ovum.

The copepod work of Retzius (1830) began and ended with a description of a new species of "lernaeid" from the North Sea. In 1822, during a short trip to Christianssund, on the west coast of Norway, Retzius examined a ray inflicted with three specimens of a new copepod. He gave a concise and precise description "of this curious animal," which he named *Lernaea dalmanni* after Professor Johan Wilhelm Dalman[20] (1787–1828) of the Swedish Academy of Sciences. Retzius published five rather good figures showing various views and details. He attempted to examine internal structures in the alcohol-preserved specimens and outlined the basic musculature and a bit of the nervous system.

All three specimens of *L. dalmanni* had egg strings. He mentioned that Grant (1827) thought that similar animals were hermaphroditic. Retzius stated (incorrectly) that Gissler (1751) had shown both sexes in a related species. Retzius was interested in the mode of attachment to the host, and he compared the attachment in his specimens to that in ten or so other species. Retzius used units of "lin. Fr. M.," which are likely French lines (see discussion in Chapter 12).

Retzius (1830) noted that "the zoologists who founded systematics are uncertain of the place" of lernaeids. He added that Schweigger's *Handbuch der Naturgeschichte* suggested that lernaeids might be crustaceans because of their likeness to several of the unusual genera of Entomostraca. Schweigger published this handbook on the unsegmented invertebrates in Leipzig in 1820. It is an obscure reference that has not yet been explored by present-day copepodologists.

Retzius (1830) is normally recorded as having been published in 1829, but that is the "volume year." The actual publication year is shown on the journal's title page as 1830. Other copepod papers by Retzius (see Vervoort 1986b) are merely abstracts or reprints of Retzius (1830).

Retzius's lernaeid, now known as *Charopinus dalmanni* (Retzius, 1830), is the type of the siphonostome genus *Charopinus* Krøyer, 1863 (see Wilson 1915, Kabata 1979). It is found on and around the gills of a skate throughout the North Atlantic and adjacent seas.

As an example of how close one might still come to greatness, I offer my interesting copy of Retzius (1830). This was from a small collection of papers bound as *Entomostraca &c.* by an English isopod/amphipod worker, Alfred Osten Walker. The reprint (actually a "separate") was inscribed by Retzius to "Herr Professor Doctor L. Jacobson, In appreciation, from the Author." I will always regret that Retzius did not sign this inscription. However, at Jacobson's death in 1843, the paper passed to and was signed by Daniel Frederick Eschricht (1798–1863), Professor of Physiology and Anatomy at the University of Copenhagen (Spärck 1933). When Eschricht died, the paper was claimed and autographed by Steenstrup, to be enshrined later in this narrative. Presumably, Walker obtained the paper, with several others in this collection, after

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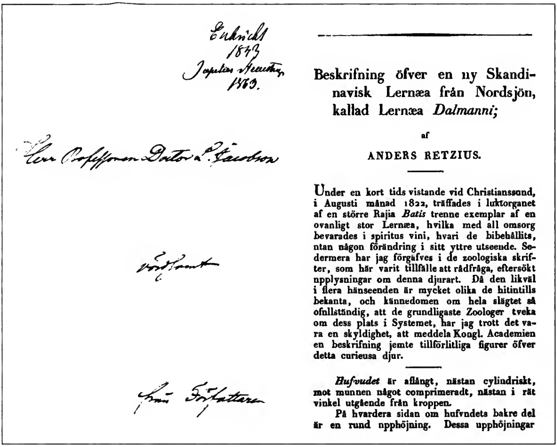
[20] The correct spelling of his name.



Eschricht
1843
Japetus Steenstrup
1863.

Herr Professoren Doctor L. Jacobson

Vördsamt

från Författaren

Beskrifning öfver en ny Skandinavisk Lernæa från Nordsjön, kallad Lernæa *Dalmanni*;

af

ANDERS RETZIUS.

Under en kort tids vistande vid Christianssund, i Augusti månad 1822, träffades i luktorganet af en större Rajia *Batis* trenne exemplar af en ovanligt stor Lernæa, hvilka med all omsorg bevarades i spiritus vini, hvari de bibehållits, utan någon förändring i sitt yttre utseende. Sedermera har jag förgäfves i de zoologiska skrifter, som här varit tillfälle att rådfråga, eftersökt upplysningar om denna djurart. Då den likväl i flera hänseenden är mycket olika de hitintills bekanta, och kännedomen om hela slägtet så ofullständig, att de grundligaste Zoologer tveka om dess plats i Systemet, har jag trott det vara en skyldighet, att meddela Kongl. Academien en beskrifning jemte tillförlitliga figurer öfver detta curieusa djur.

***Hufvudet* är aflångt, nästan cylindriskt, mot munnen något comprimeradt, nästan i rät vinkel utgående från kroppen.**

På hvardera sidan om hufvndets bakre del är en rund upphöjning. Dessa upphöjningar

Separate of Retzius (1830) given by Retzius to L. Jacobson and subsequently owned, signed, and dated by D. Eschricht and J. Steenstrup.

Steenstrup's death in 1897. Unfortunately, Walker did not sign or date it (nor did I), but he added some copepod papers received from Brady, Norman, Isaac Cooke Thompson (1843–1903), and both Scotts. I purchased the book in the early 1960s.

Retzius's son left a clear summary of his father's interests and zeal when he said that

> I remember even yet so well how a large human skeleton stood beside my bed, and how in the window were placed aquaria and jars with lizards and tree-frogs, indeed one of the bellowing giant frogs of Brazil, which when it got loose made room-high jumps. There were casks with young salmon-fry, whose further development my father studied. And each Spring when the ice broke up, he took me with him to Kungsholmbrunn, where we clattered down on the stone piers to the water's edge and gathered small water animals, infusoria, bryozoans, and worms, which we took home to the aquaria. I shall never forget my father's enthusiasm when he observed under the microscope the wonderful life which was unfolded in the water of these aquaria, and of which he with his spirited descriptive art tried to give me an inkling. I shall never forget his burning interest, his love of truth and the alert, keen look, concerning which a foreigner one time said that in case there was any proof needed for immortality, Anders Retzius's glance was such a proof. (G. Retzius, qtd. in Larsell 1924)

In the garden of the Caroline Institute is a large column mounted with a memorial bust of Retzius (Lennmalm 1908). In 1896, the Swedish Society of Physicians, to commemorate the hundredth year since the birth of this remarkable physician/naturalist, struck a gold medal inscribed with "Investigatori Naturae Sagacissimo Eximiae." One could say no more.

* * *

The copepod storyline of 1820–1830 was the nearly grasped comprehension that the generalized lernaeids were crustaceans. The narrative briefly introduced de Blainville, whose "lernaeid" memoir from 1822 stood apart from the shorter papers just reviewed. With de Blainville's work, featured in the next chapter, these copepods moved so close to crustaceans that de Blainville himself later believed that he had perfected the assignment. From our contemporary viewpoint, the metamorphoses and relationships of these parasitic copepods have been so fully confirmed and are so familiar that we read of them with little surprise.

14

STUBBORN DISPUTANT AND FASCINATING PROFESSOR

> Of all the curious creatures which the naturalist meets with in his researches, there are none more paradoxical than the Lerneae; none which are more at variance with our notions of animal conformation, and which exhibit less of that decent proportion between a body and its members which constitutes what we choose to call symmetry or beauty.
>
> —GEORGE JOHNSTON, *Illustrations in British Zoology*

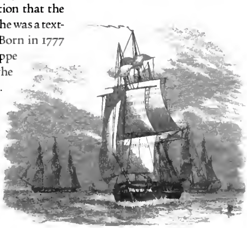
THE 1820s YIELDED one major effort on the peculiar parasitic forms. This was de Blainville's (1822a) memoir on lernaeids, the first monograph to review and revise a single, extensive copepod group. De Blainville came the closest yet to recognizing these forms as crustaceans. Indeed, with the words he used, no other conclusion was possible. However, de Blainville, probably to his everlasting regret, did not then say *these are crustaceans.* This revelation remained indirect and hidden in his cumbersome and doggedly held classification.

Henri-Marie Ducrotay de Blainville

17 February 1777–1 May 1850

I see de Blainville as a sort of inverse Rafinesque. Rafinesque showed early brilliance and promise but completely lost control in the end. As an opposite, de Blainville seemed destined from the beginning to fail in everything he tried, but ended at the pinnacle of his field. Within their hyperactive careers, both men thought grandly, both men ignored or even reviled their peers, and both embraced a nature organized in ways that only they admired.

Henri-Marie Ducrotay de Blainville's family could trace its proud Norman service to numerous kings in five previous centuries. This legacy may have left young Henri de Blainville with the notion that the world owed him something; in any case, he was a textbook example of a blueblood wastrel. Born in 1777 at Arques, on the lower Seine near Dieppe on the French coast, de Blainville was the youngest son of a father who died in 1782. No doubt this deprived de Blainville of some guidance. His earliest schooling was with the clergy, and he later attended a military school at Beaumont-en-Auge. This excellent school was, oddly enough, administered by Benedictine monks; it was closed by the Revolution in 1792 (Cap 1854, Flourens 1866, Pilleri and Arvy 1981).



For the next several months after his school closed, de Blainville was on a warship passing through some serious combat in the English Channel. At fifteen years old, he found himself back with his mother, who could not, or would not, provide direction. Believing that he wanted to be an engineer, de Blainville attended a school of design in Rouen. The director wrote prophetically to the young student's mother: "His greatest passion is a love of learning; all the rest is a chaos of ill-combined ideas" (Flourens 1866).

Henri-Marie de Blainville (1777–1850). From Cap (1854).

Even the weak domestic control was broken when de Blainville's mother died in 1796. De Blainville then squandered the next decade. Desiring to finish his courses in design, at which he did have a talent, he went to Paris. There he was aimlessly in and out of the troubles and mistakes of the period's upper-class society. "He abandoned himself to all the passions of his age, and surrounded by trifling companions, succeeded very quickly and very gaily in dissipating his whole patrimony" (Flourens 1866).

Somewhere near the age of twenty-eight, de Blainville dropped the delusions of idle youth, assessing that he was ruined and without career or family. To rebuild his life, he tried to be a poet, an essayist, a musician, a painter, and a designer. The only elements he retained were the respect for his noble birth and the love of learning. The first was a decided handicap, for he claimed privileges that had become obsolete.

The love of learning led him by chance in a completely different direction. He was greatly impressed by a physics professor during a course at the College of France. De Blainville won over the professor and was admitted to social events where he saw many of the professional authorities and dogmatic masters, one of whom was Cuvier. De Blainville's singular ambition became membership in this elite community (Flourens 1866, Pizzetta 1891).

De Blainville applied himself furiously for the next two years, at the end of which he earned his M.D. and was standing in for his professor in anatomy classes. When informed that Henri de Blainville was on a path of renown, his older brother exclaimed, "Impossible! He never had the least inclination for employment of any sort" (Flourens 1866).

De Blainville's next attack was on zoology under Cuvier, Lamarck, and Duméril; he took an exceptional interest in mollusks and zoophytes (in the broad sense), and these were to be his primary early fields. Within two more years, de Blainville stood in place of Cuvier for comparative anatomy lectures at the College of France and the Museum of Natural History. Cuvier found in this new pupil a useful collaborator, both in relieving Cuvier of duties and as a foil to expose weaknesses in Cuvier's developing doctrines. In spite of de Blainville's growing eagerness in the latter arena, Cuvier never failed to lend support and protection to his rising protégé. This was most evident in Cuvier's successful backing in 1812 of de Blainville as a new Professor of Anatomy and Zoology in the College of France. Still, de Blainville was not content to simply follow his master; moreover, his diversion was not constructive, since he appeared to choose contrary points of view as a matter of policy (Cap 1854). A break was unavoidable.

In 1814, de Blainville went to England. In discussions there, particularly with Leach, he began to think about a new classification of the animal kingdom. Upon his return, he was laden with significant specimens which Cuvier asked to see. His former pupil's response was: "That they may be more readily at your disposal, I am going to publish them" (Flourens 1866). One such publication was eventually that on the lernaeids. The nonconforming nature of de Blainville brought open warfare. In retrospect, it was he who suffered the greatest loss, deprived of Cuvier's judgment and counsel. Cuvier did not seem to fret much about these matters.

The basic difference between Cuvier and de Blainville was that Cuvier proceeded from facts to ideas, while de Blainville took the opposite and more risky approach. In fitting the facts to his ideas, and believing himself above the opinions of others, de Blainville was a walking nettle:

> It may be added, and with literal truth, that during the whole militant life of our savant there appeared nothing on natural history which did not undergo on his part a sort of adverse discussion. . . .

> He carried the war among his adversaries, and, allowing them neither peace nor truce, compelled them to hold themselves always on the defensive. (Flourens 1866)

The pupil is remembered for some remarkably ungrateful early statements to Cuvier: "I shall take my seat one day at the Institute and at the Museum, beside you, in face of you, and in spite of you" (Flourens 1866). By such language we have to assume that de Blainville considered Cuvier actively hostile. Cuvier spent most of his time ignoring de Blainville, yet he supported him still, when it counted, whether de Blainville knew it or not.

We have to admit that de Blainville ultimately triumphed on a few grand designs. Cuvier excluded continuity within the animal kingdom, believing that it was based on multiple creations of definite and separated groups without transition. The mature de Blainville took the opposite view (as we would have expected), believing that the series of beings is linked together and interadapted, a reflection of a consistent plan. To de Blainville, this was the result of a single and simultaneous creation. He denied the modification of species; the only changes were extinctions due to slow but ordinary causes.

De Blainville would have served himself better had he accepted and modified Cuvier's popular system, rather than changing it for the sake of change. Comparing the two rather similar systems:

Cuvier	de Blainville
Vertebrata	Osteozoa
Mollusca	Malacozoa
Articulata	Entomozoa
Radiata, split into	Actinozoa and Amorphozoa

Other than an explicit ascending of development, de Blainville's system had nothing to recommend it over Cuvier's entrenched system. Some of de Blainville's lower taxa had merit; for example, he was the first to break amphibians away from the reptiles. He also removed sponges from the zoophytes and the parasitic copepods from Linnaeus's *Pennatula*. But, as we shall see, his treatment of the crustaceans, within his Entomozoa, was needlessly confused and ambiguous.

By 1825, de Blainville was a member of the Academy of Sciences, as he predicted he would be. (He replaced the herpetologist Lacépède.) In 1830, a royal decree added a second professorship of invertebrates at the museum, and this was given to de Blainville. When Cuvier died, in 1832, de Blainville succeeded to Cuvier's illustrious chair at the museum. The traits that made de Blainville intolerable to his colleagues perhaps added to his teaching abilities. He was at once the "stubborn disputant and the fascinating professor" (Flourens 1866):

> Gifted with a vigorous complexion, resistant to fatigue of incessant work, with ardent imagination, a lively and critical spirit, de Blainville was an admirable professor. His elocution was easy and exuberant, his expressions strong and pleasing, frequently eccentric; his course attracted many listeners. (Pizzetta 1891)

A colleague remembered de Blainville

> passing his life in a somber apartment, buried in the depths of a vast armchair, encompassed with a triple rampart of heaps of books, original drawings, anatomical preparations and disordered instruments, if sometimes a studious disciple obtained admittance to him, it was necessary to surmount more than one obstacle, and not less difficult to find a chair than a place for it when found. If at length, after this difficult installation, reference to some volume became necessary in the heat of research, it must be drawn generally from the base of a mountain of books, whose displacement was not the less chaotic and tumultuous for being often repeated. Did an adventurous visitor, after much solicitation, obtain access to the inviolable asylum, when as yet he was scarcely more than on the threshold, and without a sense of his presence being manifested by any movement, a grave and sonorous voice would address to him the invariable question: *What is needed for your service, Monsieur?* The stranger, sometimes, disconcerted by the apparently inextricable confusion of the labyrinth before him, or aware too late of the inconvenience imposed on a profound thinker by the derangement of his ideas, would seek safety in a hasty retreat. But if the first expressions of the visitor disclosed a personage worthy of a learned conference, M. de Blainville, at once raising his head and divesting himself of the thoughts in which he was absorbed, would employ all the advantages which his facile elocution placed at the service of a vast fund of knowledge, and the auditor, charmed by so much courtesy, might expose himself, by prolonging his visit, to the danger that after his departure the laborious savant should once more repeat the phrase: *Another hour lost.* Was it a former pupil, on the other hand, who came to clear up some questionable

Henri-Marie de Blainville (1777–1850). From Pilleri and Arvy (1981).

> point, he might with confidence surmount every barrier and count on the most cordial reception; for, if M. de Blainville exacted from his disciples a species of feudal *fidelity and homage,* he at least requited it by an affection which was little less than paternal. (Flourens 1866)

We will see that one such visitor in 1837, Michael Sars, was deemed worthy of a learned conference and retained a fond impression of time spent with M. de Blainville.

Most of the rest of de Blainville's life work was toward a monograph on the comparative anatomy of recent and fossil bones. This was a continuation of one of Cuvier's projects; it had reached twenty-four large volumes by the time de Blainville died. This effort required enormous expense, but de Blainville was ill-inclined to ask for government support:

> Never was misanthrope more singularly bent on preserving all the prerogatives of an intractable humor. Taking high ground, and with reason, in regard to the value of the author and the work, he assumed that his wishes should have been anticipated. . . . He suffered of course, complained bitterly, and had the satisfaction of accusing all the world: colleges, Academy, ministry, government, all were culpable, all except himself [and] thereby only succeeded in dispelling all possibility of finishing his learned and gigantic catalogue. (Flourens 1866)

Despotic as ever, disposed to believe in his privilege to be in the right, he forgot that in the academy all seats are equal. Sensing overdue animosity, he "fairly barricaded himself, as has been shown, in the depths of his cabinet" (Flourens 1866).

Late in life, de Blainville inherited his family manor by the Normandy sea, and he returned yearly to dote on his late brother's children, having had none of his own. In the first days of May 1850, after a brilliant lecture at the Sorbonne, he headed toward Dieppe to see a sick relative and "to breathe his native air." He was found lifeless in a train car where he had only moments before taken his seat (Cap 1854).

* * *

Our interest in de Blainville stems from his earliest work during his formative zoological years, before he became the loathsome and scorning defender of grand topics. In his first publication, de Blainville (1816) outlined concise tables for a reclassification of the animal kingdom, the primary divisions of which were shown above. Copepods, as understood today, would have been placed in his Entomozoaires, a category embracing insects and worms, equivalent to Cuvier's Articulata. The Entomozoaires contained eight classes, numbered consecutively with those of more advanced groups:

- Class 10. Hexapodes (insects)
- Class 11. Octopodes (arachnids)
- Class 12. Decapodes
  - Order Brachyures (including king crabs)
  - Order Macroures
- Class 13. Heteropodes
  - Subclass Branchiopodes
  - Subclass Squillaires
- Class 14. Tetradecapodes
  - Subclass Tetraceres (isopods and amphipods)
  - Subclass Epizoaires
- Class 15. Myriapodes
- Class 16. Setipodes (annelids)
- Class 17. Apodes
  - Subclass for leeches
  - Subclass Entozoaires (intestinal worms)

A strong Lamarckian influence is seen in these categories, particularly in the subclass Epizoaires, the group on which we now focus. Lamarck had proposed the epizoans as a category to hold the lost lernaeids, which Lamarck moved from mollusks to annelids to independent class. It is interesting to see that de Blainville, who was making mollusks his special study at this time, ran counter to prevailing opinion and placed the epizoans not in the mollusks but within his Tetradecapodes, which together with his Decapodes and Heteropodes encompassed all crustaceans. Regrettably, de Blainville did not use Lamarck's Class Crustacea.

Regarding the epizoans,

> I have made this subclass a subject of particular work; it contains, besides the lernaeids and several new genera that Dr. Leach and myself believe have been established, the caligids, cyamids [isopods], chevrolles [caprellid amphipods], etc. grading imperceptibly into the Tetraceres. (de Blainville 1816)

Thus, for the first time, the lernaeids were placed with the caligids, which were held in all but name with the crustaceans. De Blainville's (1816) classification had no stated category for the free-living copepods, other than a suggestion that "some of Müller's entomostracans" might fit into the Heteropodes. However, the lernaeids held de Blainville's fascination for a decade, and his influence was paramount.

A few years later, de Blainville (1822b) made some adjustments to the 1816 classification. Now the free-living copepods (part of Müller's Entomostraca) had a rightful place in the "normal" Heteropodes, as follows:

Class Heteropodes
- Normaux: Squillaces, Branchiopteres, and Entomostraces
- Anomaux: Epizoaires

Note that de Blainville moved the epizoans from the Tetradecapodes, leaving only isopods and amphipods in the latter. The epizoans, that is, the lernaeids, were then considered as the "anomalous" Heteropodes. Still hidden in the verbiage was the fact that lernaeids were crustaceans.

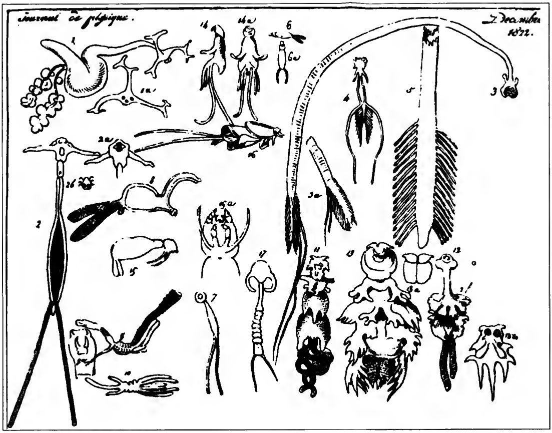
De Blainville's (1822a) near-revolutionary account of the lernaeids began with the admission that these animals are so unusual that zoologists have not known where to place them. He included a concise review of previous treatments, including Linnaeus, Bruguiere, Lamarck, Cuvier, and Bosc, who all had believed that lernaeids were mollusks. Lamarck had later placed them with the annelids (as leeches), and still later introduced the group epizoa to contain them but never connected them to caligids. Cuvier had recently fixed them among the intestinal worms as Bosc had suggested.

Oken had attempted some order within the group, urging a relationship to caligids but still retaining them as mollusks or worms. De Blainville agreed with Oken regarding the need for rearrangement within the lernaeids, and he likewise recognized the alliance with caligids. However, de Blainville's conclusion, during his voyage to England in 1814, was that lernaeids were articulated animals (his Entomozoaires) and not at all related to mollusks. He said that he was unaware of Oken's treatise when he prepared his 1816 classification. By 1822, the year of Louis Pasteur's birth, de Blainville viewed the lernaeids as anomalous worms, intermediate between his heteropods and tetradecapods.

This confused state arose, de Blainville (1822a) said, because no one had yet looked carefully at lernaeid anatomy. That was true, and de Blainville did much to set this aright. His comments on lernaeid morphology were unprecedented. He outlined the traces of true appendages in most species, with "rudimentary subarticulate antennae." He noted further that some species had evidence of a sessile eye. Many of the other descriptive terms de Blainville used could have led zoologists to no other categorization than that of crustacean: head, cephalothorax, thorax, abdomen, subarticulate palps, articulated legs, crustaceous shield, eggs and egg sacs, and a pair of moveable hooks at the mouth.

The validating point would have been the evidence from larval development. However, it seemed as if de Blainville barely believed what he had learned of

> the curious observation of Doctor Surriray [*sic*] of Havre. According to this observation, the new-born animal has a form that it loses by steps with advancing age; this form is much more perfect, and less anomalous, than that which it acquires, and therefore this is a kind of metamorphosis in an inverse sense to that which is the usual. We are ignorant of the existence of separate sexes in these animals.



Copepods from de Blainville's monograph of 1822.

> Dr. Surriray found [a lernaeid] on two kinds of unnamed fish at Havre. From one he teased away eggs each of which contained an embryo ["fetus"] similar to monoculus species (these are his terms) having six very large feet, and upon the back three black spots, one in front and in the middle, and two behind; so that, he adds, these embryos do not resemble their mothers any more than do those of caligids.

> We know nothing of the circulatory or nervous systems. Still less is known regarding behavior, but all species up to now are found on different parts of freshwater or marine fish. It is difficult to conceive how the animal leaves the egg and attaches itself to fish, although one can see that as juveniles they can move somewhat. Of one thing we are certain, and that is that one species is not necessarily bound to a single fish species. (de Blainville 1822a)

In spite of these descriptions and the figure of the nauplius from Suriray that de Blainville reproduced, de Blainville's continual circling around the main point maintained a needless ambiguity. Even de Blainville's first major reviewer, Desmarest (1825), as we shall see, was unsure of the conclusions. Cuvier, in his last works, did not accept that lernaeids were crustaceans because of this problem of males not yet having been described. De Blainville only saw the lernaeids as a "family in a gradation of organization that approaches the caligids" (de Blainville 1822a). He would not be plainer than that.

For the lernaeids as a group, regardless of their position in the scale of nature, de Blainville's was an admirable effort. He described eight genera (seven were new), described or commented on thirty-six species, and compared lernaeids with three other genera and caligids. Seventeen of the species were illustrated. A figure of *Anthosoma smithi* was included "to show the gradation of the lernaeids toward the caligids, which are for all zoologists entomostracans." It is obvious that de Blainville summarized the lernaeid literature and looked at many fresh specimens. He felt that four species had been inadequately described. The one previous genus name that was retained was *Lernaea* of Linnaeus: "under this name are the species of lernaeids that have no trace of appendages either on the body or on the head, that is to say, they are the most formless species" (de Blainville 1822a).

De Blainville's monograph is not easy to follow; some figured species are not mentioned in the text, and all species listed in the "explanation of figures" are headed "L.," in spite of the introduction of seven new genera each beginning with "L." Therefore, I interject a list of species from the text as well as the species mentioned only in regard to the figures; Dr. Z. Kabata has kindly provided modern equivalents, in **bold**:

- *Lern[a]eocera* n. gen.
  - 1. *Lern[a]eocera branchialis* (Linnaeus) [parentheses are added here to authors as appropriate] (Fig. 1) [= ***Lernaeocera branchialis*** (Linnaeus, 1767)]
  - 2. *Lern[a]eocera cyclopterina* (Müller)
  - 3. *Lern[a]eocera surriraiis* n. sp. (Fig. 2) [= ***Lernaeenicus encrasicoli*** (Turton, 1807)]
  - 4. *Lern[a]eocera cyprinacea* (Linnaeus)
- *Lerneopenna* n. gen.
  - 1. *Lerneopenna bocconii* n. sp. (Fig. 3) [= ***Pennella sagitta*** (Linnaeus, 1758)]
  - 2. *Lerneopenna sagitta* (Linnaeus) (Fig. 5) [= ***Pennella*** **sp.**, posterior extremity]
- *Lernaea* Linnaeus
  - 1. *Lernaea clavata* Müller
  - 2. *Lernaea basteri* n. sp.
  - 3. *Lernaea cyclophora* n. sp. (Fig. 7) [= ***Lernaeenicus sprattae*** (Sowerby, 1806), copied from Sowerby; see Fig. 17]
- *Lerneomyzon* n. gen.
  - 1. *Lerneomyzon uncinata* (Müller)
  - 2. *Lerneomyzon pinnarum* (J. C. Fabricius)
  - 3. *Lerneomyzon pyriformis* n. sp. (Fig. 8) [= ***Clavella adunca*** (Strøm, 1762)]
  - 4. *Lerneomyzon pernettiana* n. sp.
  - 5. *Lerneomyzon elongata* n. sp. (Fig. 9) [= ***Brachiella thynni*** Cuvier, 1830; see Fig. 10]
- *Lernentoma* n. gen.
  - 1. *Lernentoma radiata* (Müller)
  - 2. *Lernentoma gobina* (Müller)
  - 3. *Lernentoma nodosa* (Müller)
  - 4. *Lernentoma asellina* (Müller)
  - 5. *Lernentoma trigla* n. sp. (Fig. 12) [= ***Lernentoma asellina*** (Linnaeus, 1758)]
  - 6. *Lernentoma cornuta* (Müller)
  - 7. *Lernentoma dufresnii* n. sp. (Fig. 11) [= ***Chondracanthus lophii*** Johnston, 1836]
- *Lernacantha* n. gen.
  - 1. *Lernacantha delarochiana* [new names for Delaroche's genus and species] (Fig. 13) [= ***Chondracanthus zei*** Delaroche, 1811]
- *Lern[a]eopoda* n. gen.
  - 1. *Lern[a]eopoda brongniartii* n. sp. (Fig. 15) [= ?]
  - 2. *Lern[a]eopoda salmonea* [a new genus for an old species, presumably Linnaeus's]
- *Lernanthropus* n. gen.
  - [1.] *Lernanthropus musca* n. sp. (Fig. 14) [= ?]
- De Blainville's undetermined genera
  - 1. *Lernaea huchonis* Schrank
  - 2. *Lernaea lota* Hermann
  - 3. *Lernaea adunca* Strøm
  - 4. *Axine bellones* Oken
  - 5. *Oestrus* Gessner
  - 6. "Eye-sucker" Baker
- In de Blainville's figures, but not in text
  - [1.] *Lerneopenna brachiata* n. sp. (Fig. 4) [= ***Pennella*** **sp.**, a young female]
  - [2.] *Lernaea* du congre n. sp. [i.e., "lernaeid of the conger eel," but source not given] (Fig. 6) [= ***Congericola pallidus*** P. J. van Beneden, 1854]
  - [3.] *L.* [probably *Lerneomyzon*] *incisa* n. sp. (Fig. 10) [= ***Brachiella thynni*** Cuvier, 1830; see Fig. 9]
  - [4.] *L.* [genus not stated] articulee n. sp. (Fig. 17) [= ***Lernaeenicus sprattae*** (Sowerby, 1806), copied from Sowerby; see Fig. 7]
  - [5.] *Anthosoma smithi* Leach (Fig. 16) [= ***Anthosoma crassum*** (Abildgaard, 1794)]

Four of de Blainville's genera survive: *Lernaeocera* and *Lernaeopoda,* the basis of siphonostome families, with these new spellings (Illg 1955); *Lernanthropus,* the basis of a third siphonostome family; and *Lernentoma,* a chondracanthid poecilostome.[1]

Two of de Blainville's genera were explicit synonyms and so are not used: *Lerneopenna* (for Oken's valid *Pennella*) and *Lernacantha* (for Delaroche's valid *Chondracanthus*). The last de Blainville genus, *Ler-*

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[1] De Blainville said that his new genus and species *Lernanthropus musca,* parasitic on a diodon from Manila, was so named because of the resemblance to a man's head joined with a fly and its wings. Based on his drawing, this is quite a fancy!

neomyzon, is the lernaeopodid siphonostome genus *Clavella* Oken (see Wilson 1915).

De Blainville proposed sixteen new names for species. Three of these (*cyclophora, delarochiana,* and "articulee") were explicit synonyms and retain the older names; five others (*brachiata, bocconii, pyriformis, trigla,* and *dufresnii*) are usually known by other names, although *Lernentoma dufresnii* is older than its synonym. Another two are the type species of de Blainville genera: *Lernaeopoda brongniartii* (of unknown source and never seen again) and *Lernanthropus musca* (see Kabata 1979). The rest of the new species names fared equally poorly: one ("du congre") was not a binomial, and five (*basteri, elongata, incisa, pernettiana,* and *surriraiis*) are held by some to be of uncertain status.

Two of de Blainville's new species had a complicated origin, "an amusing mistake on the part of M. de Blainville":

> In 1806, Mr. Sowerby . . . gives a figure of [*Lernaeenicus sprattae*], of the natural size *in situ,* attached to the eye of the little fish, and part of a magnified sketch, representing the head and neck, detached. . . . How [de Blainville] saw the original figures of Sowerby it is difficult to say; perhaps in the possession of Dr. Leach. He has, however, in his paper . . . so often quoted above, reproduced the two figures, the one *in situ* of the natural size, the other the magnified sketch of the upper portion only, and described them as two distinct species! The only information, he adds, that he has concerning the two species is, "that they are copied from MS. drawings of the English voyage to the Congo"! The figure of the one *in situ* he names the *Lernaea cyclophora,* the eye of the sprat of Sowerby's figure being described as the round head of the Lernea! while the magnified figure he merely designates as "Lerneide articulee," the outline of the unfinished short portion or commencement of the body of Sowerby's sketch being taken by him as the oviferous tubes! (Baird 1850)

The fact that Sowerby (1806) found his species around the British Isles makes de Blainville's mistakes even more grievous. De Blainville's phantom species were not, as he stated, from the Congo.

De Blainville's (1822a) monograph had little authority in the placement of the group, still buried as it was in the quagmire of unfamiliar terms. In contrast, his influence on the status of genera and species was long-lasting, and even long-misleading in some cases. The damage was caused by de Blainville's disregard of priorities. For example, de Blainville reasonably described a new genus *Lernaeocera* for Linnaeus's *Lernaea branchialis,* but he also said that Linnaeus's *Lernaea cyprinacea,* since 1758 a perfectly good and altogether different species, was in the same genus. The result was that many subsequent authors (even more unaccountably) exchanged the type species between the two genera, making the incorrect combinations "*Lernaea branchialis*" and "*Lernaeocera cyprinacea.*" These combinations resulted in species that fit neither of the definitions for their genera. This error was repeated by Desmarest (1825), Nordmann (1832), Burmeister (1835), Krøyer (1837), and Milne Edwards (1840). It took a century to straighten it out:

> In such a dilemma only one course is possible, and that is to restore the two genera to their proper places, in spite of the great inconvenience which will result, and this has been done. The author sincerely regrets the necessity for such a change, especially when the genera are so widely known and so often quoted, but the evidence is so convincing as to leave no choice in the matter, and both Linnaeus and Blainville have claims for justice which far outweigh any temporary embarrassment. (Wilson 1917a)

But even Wilson thought that the two genera were members of the same family because of the superficial resemblance and the similar host-parasite relationship; in fact, they belong to two different orders (Kabata 1979).

This landmark contribution was essentially repeated the following year, without illustrations, in the popular "Dictionary of Natural Sciences" (de Blainville 1823). De Blainville dropped the ill-starred *Lerneopenna brachiata* and "*Lernaea* du congre." Ignoring priorities, although obviously not claiming pride of discovery, he submitted a new name, *Lerneopenna holteni,* for *Lernaea exocoeti* Holten, which he only mentioned in 1822.

* * *

Desmarest (1825) apparently did not digest de Blainville's material in time for incorporation into the main text of his "general considerations." He did, however, abstract the dictionary entry (de Blainville 1823) to add as a long footnote to his discussion of crustacean classification. His comments confirm de Blainville's ambiguity; nevertheless, Desmarest said that it was "most probable" that the lernaeids make up a part of the crustacean parasites allied with *Caligus* Müller:

> But the characters which we have indicated do not exist to the same degree of development in all the creatures which are debated; and, between an organization sufficiently complicated as a *Caligus,* and that which is appropriately said to be very simple in lernaeids, one finds the degradations in such faint degrees, that one cannot indicate a line that separates the animals derived from the two types. It will therefore be absolutely necessary to unite them. But where to place them? By making one particular class, as was done by M. de Lamarck, under the name of Epizoaires? Or placing them, as M. Cuvier, part in the class Crustacea, and part in the intestinal worms? Or better, to recognize that the caligids are true Crustacea, and arrange with that series the lernaeids which cannot be separate creatures?
>
> Not yet having reached a determination in this regard, of which the last appears to me preferred over the others, even introducing into the class Crustacea some species which do not display any evident characters that would distinguish them, I believe that it is useful to report here a short extract of the work of M. de Blainville, in order to be complete in the point raised of the knowledge acquired relative to the Crustacea, to which, at the very least, these animals are the nearest. (Desmarest 1825)

Desmarest (1825) reminded his readers of the "observations of M. le docteur Surriray du Havre" on the metamorphosis of lernaeids and that "they are closer in their form to the larvae ["têtards"] of the entomostraca." He added the recently discovered *Lernaeopoda stellata* Mayor, 1824 to de Blainville's species list.

* * *

Several years later, de Blainville fashioned one last opportunity to surrender his lernaeids to posterity. To examine this, it is necessary to look forward eleven years to an early work of yet another champion of French zoology and paleontology, Paul Gervais.

Paul François Louis Gervais

26 September 1816–10 February 1879

Paul François Louis Gervais was born in Paris with precocious talents toward natural history. By the age of nineteen, he was an assistant naturalist at the museum, under de Blainville, with a published description of a new bird species from Senegal (Pilleri and Arvy 1981). In 1844, Gervais successfully defended a thesis on fossil birds, enabling him to obtain the professorship of zoology at the University of Montpellier the following year. He was later the Dean of the Faculty of Science at Montpellier. In 1856, Gervais added an M.D. to his honors, with a treatise comparing human and other vertebrate skeletons.

By 1865, Gervais had returned to Paris, to the Chair of Anatomy, Physiology, and Geology at the Sorbonne. In 1868, he was appointed Professor of Comparative Anatomy at the museum, where he reorganized the zoological collections, with large additions. In addition to his academic pursuits, Gervais committed much time attempting to acclimate salmon to the Hérault; none of the rivers opening into the Mediterranean had native salmon stocks.

Agassiz (1853) and Pilleri and Arvy (1981) listed approximately sixty Gervais publications in virtually all zoological groups "from Foraminifera to man." He coauthored with notable zoologists, one of whom, Pierre Joseph van Beneden (1809–1894), we will meet in a significant copepod context. Gervais died in 1879 (Økland 1955, *Webster's* 1960), not in 1889 as reported by Pilleri and Arvy (1981).

One Gervais publication that was not recorded by Agassiz (1853) or in the copepod literature is a revision of de Blainville's work on lernaeids (Gervais 1836). This seems to be the only Gervais copepod publication, although he had many on zoophytes of the limited sense. Undoubtedly de Blainville was asked to contribute to another compendium, the "Picturesque Dictionary of Natural History and Natural Phenomena." Neither de Blainville's nor Gervais's name appeared on the 1833 list of contributors—Gervais would have been only seventeen years old. The lernaeid article, of 1836, is signed "Gerv." Under the circumstances, I believe it can be no other than Paul Gervais. The list of contributors held many notable names; however, the only one that will be mentioned in our copepod narrative is Pierre Hippolyte Lucas (1814–1899), at that time also an "aide naturaliste" at the museum.

Following popular usage, the articulate animals formed four classes: annelids, arachnids, insects, and crustaceans, forever denying de Blainville any credit for his clumsy system. As if this was not a sufficient impact, the lernaeid article began im-

Paul Gervais (1816–1879). From Pilleri and Arvy (1981).

mediately with "(Crust.)," which the introduction defines as "Crustaces." Compare this with de Blainville's (1823) dictionary entry that began with "(Entomoz.)." Thus, de Blainville's Entomozoa went down without a ripple.

Gervais began with the by-then standard literature review of lernaeids but added:

> The honor of having determined with precision the position that lernaeids must occupy in the zoological series belongs to M. de Blainville. This naturalist published in 1822 in the Journal de physique, and in 1823 in the Dictionary of Natural Sciences, an excellent article on these animals, and he has demonstrated that they must be placed among the crustaceans and alongside the caligids and the argulids. In 1816, in his Prodromus of a classification of the animal kingdom, inserted in the Bulletin of the Philomatic Society, M. de Blainville had already arrived at this conclusion. (Gervais 1836)

Not exactly true! But Paul Gervais was only nineteen years old and a student of the irrepressible de Blainville; what else could he have said?

Gervais/de Blainville followed this with a plea for additional studies on the group, especially with respect to remaining reproductive mysteries. It was stated that there was still no information on different sexes; however, Nordmann (1832), which was cited, did have such, and Nordmann proved once and for all the crustacean nature of the lernaeids. Other records were mentioned: Lesueur (1824) and those of Kollar and Burmeister (yet to be covered in our narrative). The reader was reminded that Desmarest and Milne Edwards held the opinion that lernaeids were crustaceans, but that Cuvier did not.

The list of species was modified, generally for the better, but there were some serious mistakes. Several new illustrations added usefulness, even though Plate 251 arranged *L. branchialis* under the intestinal worms. Several ill-conceived species were dropped, and some respectable species, especially Cuvier's, were added from the literature since 1822.

Gervais (1836) explained that even though *Lerneopenna* was identical to Oken's *Pennella*, de Blainville "replaced it for symmetry." Today, this is not an acceptable practice; I suspect that de Blainville was reproached for it in his time as well. Oken, for one, would not likely have endorsed it. In the same vein, de Blainville coined *Lernacantha*, "to give greater precision" over *Chondracanthus* Delaroche.

Copepodologists owe another, although indirect, debt to Gervais. When Michael Sars visited Paris in 1837, de Blainville introduced him to a "kind, young naturalist" who showed Sars some of the zoological and anatomical collections and the library. This was Paul Gervais. Their museum made a strong impression on Sars, even more, he said, than did the Leiden Museum, and Sars saw many things that were new to him (Økland 1955).

It is likely that de Blainville assigned Gervais to Sars, but we detect no reluctance on Gervais's part in Sars's diary. Through most of the summer of 1837, Gervais brought Sars to the Sorbonne ("the old University"), the Jardin, other naturalists, the "best bookstores near the medical school," city and country scenes, plays, meals, and, most importantly, to the Academy of Sciences where Sars delivered a report on his research. Two weeks before the session at the academy, Gervais had "come early" to help Sars with his French translation. On the day itself, 17 July, Gervais conveyed Sars to the Institute of France. Then, Sars noted, Gervais "went home"; the academy's sessions were closed to the unannointed, even in this situation.

Having benefited more than once by similar assistance in foreign climes, I know that Gervais made a vital contribution to Sars's successful visit. I have endeavored to repay such kindnesses, whether to the giver or to another, in the hope that the worthwhile tradition will carry on.

On 15 August 1837, after a long and enjoyable day, Sars "had a heart-felt leave-taking with Gervais, who had become a very good friend, my altogether indispensable companion" (Økland 1955). When Sars left Paris for Germany the next day, he carried letters and papers to be delivered for Gervais and others.

* * *

In spite of his posturing, we must credit de Blainville with a major copepodological advance. His was not a Rafinesqueian voice in the wilderness, even though much of what he left to science is now forgotten. The "some good/some bad" characterization had been summarized well by a contemporary:

> The only other classification [of the zoophytes] I shall notice is Blainville's—the most elaborate of any; and this author, as it appears to me, is the first who allowed the anatomy of the Polypes, abstractly considered, to have its due influence on our systems. Notwithstanding, however, Blainville's unquestionable merits, his very defective acquaintance with species will ever prevent him becoming a first-rate systematist: he may sketch the outline, the details he cannot supply, and his attempt has exposed him to numerous errors: he is too fond of generalizations where his facts are few and specifical; he wants the necessary neatness and brevity of definition, and he evinces everywhere such a total disregard to the old nomenclature that his system is not likely to become popular, or to be generally adopted. Many of his alterations are excellent, and must meet the approval of all. (Johnston 1847)

De Blainville was as well placed and influential as anyone in his day. He contributed over 175 published works to zoology, covering as wide a field as could be imagined (Agassiz 1848, Pilleri and Arvy 1981). He was a member, from 1812, and later secretary, of the Société Philomatique; from 1816 he edited the zoology and physiology section for its *Bulletin des Sciences.* From 1813, de Blainville edited the *Journal de Physique,* which was owned by a friend (Pilleri and Arvy 1981). His works on mollusks, particularly, were extremely influential and still sold as late as 1870.

De Blainville held membership in many foreign organizations, such as the Royal Society of London and the Philosophical Society and Academy of Natural Sciences of Philadelphia. He was a member of France's Legion of Honor.

De Blainville strengthened copepodology by moving the lernaeids away from the mollusks and decidedly closer to crustaceans, even though his treatment was tangential and confused. Perhaps de Blainville's greatest bequest to our science was another student, Henri Milne Edwards, who gave the eulogy at de Blainville's funeral. Milne Edwards, a giant of the next generation, has been mentioned several times and will share the center of copepod research in the 1830s. Another de Blainville student was Edward Forbes, who did not work with copepods but who had tremendous direct and indirect influence over many who did.

* * *

In the decade leading up to 1830, the broadly perceived group of lernaeids was split into several new genera and species, and new distribution records were published. Retained in our time are four de Blainville genera (*Lernaeocera, Lernaeopoda, Lernentoma,* and *Lernanthropus*). Most new species proposed by de Blainville did not withstand later scrutiny, and only two marine species persist; one was from the Philippine seas, while the source of the second species remains unknown. Other researchers listed three additional new marine species, from Norway (Retzius), the Atlantic coast of the United States (in Lesueur's new genus *Lernaeenicus*), and Arctic seas (Grant's vague locality, but the first described copepod from these waters). There were two new freshwater species recorded, from Norway (Mayor) and Lake Erie (Lesueur). Two older species widened their reported distribution to Switzerland (Mayor) and to the east coast of the United States (Lesueur). The caligids and other parasitic copepods that even then were acknowledged as crustaceans received one new genus and three new species: *Nicothoe astaci* from the Channel coast of France (Audouin and Milne Edwards), and two caligid species from Nice (Otto).

There were some additions to the registry of free-living copepods during the 1820s. Only one marine species (from the Indian Ocean) was noted and consigned to the copepod catacombs because of its ambiguous description. However, the author, J. V. Thompson, embedded the gemlike *Sapphirina* among the most endearing and enduring copepod genera. From Switzerland, Jurine named six or seven new species, all in the old genus *Monoculus.* (These are now assigned to the old genus *Cyclops* or to the subsequently established *Diaptomus* and *Canthocamptus.*) Jurine also nearly solved the riddle of copepod reproduction.

Chronologically, Retzius (1830) belongs in the decade of the 1830s, but his work blended best with the numerous short reports from the 1820s. For similar reasons, some short papers by Johnston and by Burmeister, from 1824 to 1830, are best revealed with their more significant work from the 1830s. Our narrative has foreseen the later work of DeKay (1844), and some of his copepods just recorded are of that period.

The first extensive copepod records of the 1830s are those of Nordmann (1832), to be reviewed in Chapter 15. It was through his definitive work that the mislaid lernaeids came resolutely into the copepod camp.

15

COPEPODS DECODED

> The chapter in Dr. G. Johnston's British Zoophytes . . . is really a saddening one, as one sees how loth were not merely dreamers like Marsigli or Bonnet, but sound-headed men like Pallas and Linne, to give up the old sense-bound fancy, that these corals were vegetables, and their polypes some sort of living flowers. Yet, after all, there are excuses for them. Without our improved microscopes, and while the sciences of comparative anatomy and chemistry were yet infantile, it was difficult to believe what was the truth; and for this simple reason: that, as usual, the truth, when discovered, turned out far more startling and prodigious than the dreams which men had hastily substituted for it; . . . one smiles at it now: yet these men were no less sensible than we of the year 1854; and if we know better, it is only because other men, and those few and far between, have laboured amid disbelief, ridicule, and error; needing again and again to retrace their steps, and to unlearn more than they learnt, seeming to go backwards when they were really progressing most: and now we have entered into their labours, and find them, as I have just said, more wondrous than all the poetic dreams of a Bonnet or a Darwin.
>
> Who, after all, . . . would have dreamed of the "bizarreries" which these very zoophytes present in their classification?
>
> —Charles Kingsley, *Glaucus*

AN AFFINITY BETWEEN the highly modified copepod parasites, such as lernaeids, and the less modified parasites, such as caligids, was suggested by Lamarck, Oken, and others, but it was not until the work of Alexander von Nordmann (1832) that all of these forms were proved to be related. And never again, after Nordmann, would a zoological oracle, such as Cuvier, proclaim that the parasitic copepods were anything but Crustacea.

There is an excellent Swedish biography of Nordmann by Hjelt (1871), and most of Nordmann's life details were taken from this, as translated by my mother. The biography was from an address given for the anniversary of the Finnish Science Society in 1867 to honor its former leader and wide-ranging international scientist.

Alexander von Nordmann

24 May 1803–25 June 1866

Alexander von Nordmann was born in Ruotsensalmi, on the southern seacoast of Finland, on 24 May 1803, and he is therefore the first of our featured copepodologists to have been born in the nineteenth century and the first for whom I have a photograph. Ruotsensalmi (now Kotka) is on the Gulf of Finland east of Helsingfors, about half way to Vyborg. Finland was then in one of its historical transition periods, and Nordmann missed by two years being a citizen of Sweden; by 1809, Russia governed Finland. Nordmann was the oldest alongside ten brothers and sisters. His father, David Anton von Nordmann, an officer in the Russian artillery, was

Alexander von Nordmann (1803–1866). From Elfving (1921).

exceptionally interested in local birds and fishes, and he encouraged similar interests in his receptive son, who enjoyed wandering and observing from an early age. Nordmann's mother was Maria Ekaterina Gesling. The Nordmanns were of Swedish and Finnish ancestry; Nordmann's paternal grandfather was a councilman in a Swedish district, but because of his nearness to the border with Finland, he began to work for the Russians and eventually moved to Finland. The common language for Nordmann's circle was German, which was his mother tongue. At ten years of age, young Nordmann was sent to a German school at Fredrikshamn; he advanced rapidly through this and other schools. One of his teachers had an exceptional insect collection that greatly impressed the budding naturalist. In this early time, Nordmann obtained the fundamentals of botany and enjoyed reading about explorations (Hjelt 1871, Puzanov 1969).

In 1821, Nordmann went to the Åbo Academy to seriously pursue natural history studies.[1] Åbo (its Swedish name, now Finnish Turku), west of Helsingfors on the Gulf of Finland, was an important port of entry; it was also the Finnish capital until 1812. An influential university professor, Carl Reinhold Sahlberg (1779–1860), was one of the greatest Finnish entomologists (Saalas 1956). Sahlberg had studied under and worked with two of Linnaeus's students, and he had been as far afield as the Crimean Peninsula and the Caspian Sea. Sahlberg, with good nature and humor, conducted popular field trips and shared much of his enthusiasm, experience, and respect for nature; he and Nordmann remained lifelong friends:

> The worthy entomological veteran Dr. Carl Reinhold Sahlberg, an adored teacher and advisor, had an unheard of propensity to stimulate his pupils to collect and study insects. Professor Sahlberg, who was also my highly regarded teacher, understood to the fullest degree, how to adapt his students' enthusiasm and love to entomology, and I still recall with sincere delight and joy the pleasant excursions which were undertaken in the surroundings of Åbo, Runsala, and toward Ylane during the years 1822–26, often in the company of Count Mannerheim . . . and other friends. . . . Sahlberg's keenest and best student was Mannerheim, but not for long, because the student surpassed the teacher, as often happens with encouragement. (Nordmann 1856)

These memorable excursions set Nordmann's life pattern; hardly a year went by without Nordmann participating in some extended exploration.

The first meeting of the Societas pro Fauna et Flora Fennica, the first true science society in Finland, was held in Sahlberg's home in 1821, and Nordmann was a participant (Elfving 1921, Saalas 1956). In response to the proposed *Fauna and Flora of Finland,* Nordmann joined in numerous extended surveys. His contribution was an 1824 insect collection from Tavastland, in south central Finland. During this time, Nordmann worked with several important foreign entomologists. He also made himself proficient in the Russian language and until 1826 earned money as a translator in the border town of Åbo. He received a Ph.D. with honors from the University of Åbo in 1827.

To widen his academic experience, Nordmann decided to go to Germany in 1827. This was unusual for any Finnish naturalist of the time. The move was made especially difficult that year by the death of Nordmann's father and resulting lack of financial support from his family. Nordmann sailed from

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[1] This is now the Åbo Academy University, founded in 1640, with Swedish still its official language. Finland's first natural history publications (botanical) were from the Åbo Academy in 1673. In the late 1700s, the academy received a strong influx from Linnaeus's students (von Bonsdorff 1912, Elfving 1921).

Fredrikshamn to Lübeck, Germany, where he spent some weeks enthralled by the unfamiliar flora. After a short visit to Hamburg, Nordmann went to Berlin as a student of the medical faculty at the University of Berlin. Nordmann had aimed for this distinguished scientific center because of the fame of its faculty. For Nordmann, the most significant professors were Karl Asmund Rudolphi (1771–1832) and Christian Gottfried Ehrenberg (1795–1876).

Rudolphi was born in Stockholm of German parents. He obtained a medical doctorate at the German University of Greifswald in Swedish Pomerania. He stayed for a time as Professor of Anatomy but joined the University of Berlin soon after its founding in 1813. He was a disciple of Cuvier in his treatment of descriptive and comparative anatomy. Rudolphi began the Berlin Zoological Museum, which became one of the finest in the world. He was a zealous yet sensitive scientist, highly regarded by his pupils and colleagues. One pupil, Johannes Müller, was eventually Rudolphi's successor, himself with an array of pupils seldom equaled in science (Nordenskiold 1928).

Rudolphi impacted three branches of biology. His significant microscopical studies of vertebrate intestinal tissues fixed his place in comparative anatomy and made him one of the first histologists. His series *Grundriss der Physiologie* from 1821, which dispelled considerable mythology around human physiology and anatomy, was probably his most important work.

It was Rudolphi's third field, his pioneering work with parasites, that brought him, probably unknowingly, into the copepod cosmos. Rudolphi had especially improved on earlier work by Goeze, as naturalists began to make sense out of Linnaeus's catchall group Vermes. Many of the foremost persons who contributed to the expansion of this field would also be familiar to copepodologists. Rudolphi's work with intestinal worms so broadened and stabilized the field that all subsequent work is based on it (Garrison 1914, Hyman 1951). It was from Rudolphi that Nordmann gained his interest in parasitic worms and obtained a thorough background in their systematics and morphology.

Alex. v. Nordmann

Alexander von Nordmann (1803–1866). Courtesy of the Zoological Institute, University of Helsinki; signature from 6 September 1862 letter to Leiden Museum of Natural History, courtesy of the Nationaal Natuurhistorisch Museum, Leiden.

Ehrenberg had been a student at the University of Leipzig in the period 1815–1820. In 1827 he had just returned, as the only surviving principal, from a five-year expedition to Egypt and east Africa. In spite of the hardships and loss of life, the expedition was deemed successful because of its scientific discoveries. Part of this was the basis for Ehrenberg's pioneer investigations on protozoan ("infusorian") structure, development, life history, and fossils. Clay and Court (1975) called Ehrenberg "a microscopist of the first rank."

Although Alexander von Humboldt was an independent scholar and not formally connected with the university, he moved freely within that sphere. Nordmann became acquainted with this most remarkable of scientists.

Nordmann had a difficult adjustment to university life in Germany, primarily because of his financial circumstances. As a result, he became accustomed to having little in the way of material things. When his formidable talent for drawing became known, he earned money doing this work for others. For example, many of Ehrenberg's plates were done by Nordmann. After a short time, Nordmann also received support from the Russian minister, who gave him a fine microscope made by Chevalier.[2]

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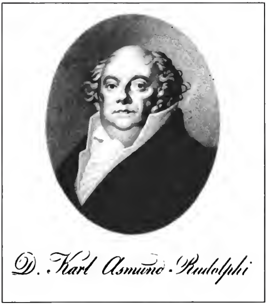
[2] Charles Chevalier was the leading French optician (Clay and Court 1975).



Karl Asmund Rudolphi (1771–1832), helminthologist and Nordmann's professor at the University of Berlin; portrait from 1820. Courtesy of the National Library of Medicine.

Naturally such teachers attracted and produced eager lecturers and students, and many of these acquired fame in later life. Nordmann subsequently indicated (with †) those who had died, and I have italicized the copepod notables:

> I might once again in remembrance recall the still-living friends and colleagues from my Berlin youth, [and] that the first class (Physiology of the Lower Animals, October 1830) of Prof. C. G. Ehrenberg was comprised of the following companions: Doctors F. Brandt, *H. Burmeister,* W. F. Erichson (†), C. Hoppfer, *S. L. Lovén,* J. F. Ratzeburg, *C. T. v. Siebold, A. F. Wiegmann* (†) and me. I think we all remained without exception true to our teacher's standards. To the good-natured botanical evening-band belonged in addition: N. Bartels (†), Bouche, Beyrich (†) in America, *A. v. Chamisso* (†), Jul. Fritzsche, Kunth (†), Lucae (†), *F. J. Meyen* (†), and *R. A. Philippi* (in Chili). (Nordmann 1856)

Nordmann's friendships here endured for his lifetime, and the Berlin experience opened for him a large, new, exciting, and accessible world of natural history. Nordmann retained a lifelong respect and gratitude for Rudolphi and Ehrenberg. These were probably his best years, and Nordmann made the most of these superior opportunities.

In the Berlin years, Nordmann formed lasting personal relationships with many who were later to praise his work. Nordmann had several opportunities to meet like-minded foreigners, particularly from northern Europe, at naturalists' meetings in Berlin (1828, presided over by Humboldt) and in Hamburg (1830). Among those already mentioned in our narrative were Retzius from Stockholm and a young professor from Königsberg, Karl Ernst von Baer. An excursion to Helgoland was undertaken in conjunction with the Hamburg meeting. The travelers included Nordmann, Chamisso, and Oken. In 1829, Nordmann crossed through the Harz Mountains on the way to Göttingen to meet Blumenbach, Siebold's future professor.

Georg Adolf Erman (1806–1877), a physicist, offered Nordmann the birds collected on his trip around the world on a Russian frigate from 1828 to 1830. Nordmann described several new species out of 143 species in the collection; Chamisso described the plants and Burmeister some invertebrates from this journey. The specimens were among the first for the new Berlin Zoological Museum. Apparently, with so many diversions, it was difficult for Nordmann to focus on worms and parasitic copepods, but his "kindred spirit and ftiend Chamisso, the clever, more solid, and erudite traveler-naturalist," kept him on course (Puzanov 1969). Another of Nordmann's friends wrote a long poem in 1831, reflecting the endless natural history enchantments at every turn (Nordmann 1865). More than one verse made Nordmann the subject of entomological seduction, for example:

Und nach Nordmann eilt er mit schnellem Schritt,
Kommen Sie, ruft er, kommen Sie mit.
Verlassen Sie Ihre Entomostraceen,
Wir wollen auf den Käferfang gehen.

[And with rapid step to Nordmann hastened he,
You must come, he called, you must come with me.
Forget your Entomostracans,
To beetle-catching we'll attend.]

—NORDMANN (1865)

In his five years at the University of Berlin, Nordmann worked mainly with invertebrates under Rudolphi and Ehrenberg. The culmination of this effort was the first part of the 1832 *Mikrographische Beiträge,* dealing with parasitic worms. The second part of these micrographic contributions dealt with parasitic copepods, and it is one of the watershed works in our field. Its publication in Berlin led Baird (1850) to refer to Nordmann as "an eminent Prussian naturalist." With this outstanding and revolutionary study, Nordmann showed once and for all the crustacean nature of these puzzling parasites. Because of their beauty, utility, and rarity, I have reproduced Nordmann's plates in my narrative.

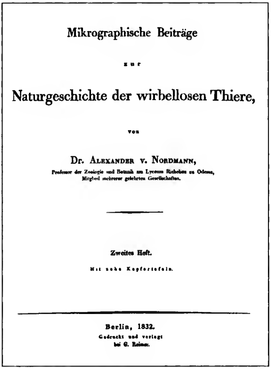
It should not be surprising by now that Nordmann's copepodological magnum opus came from a study of parasitic worms. Given, as Nordmann (1832) said, the "shabby treatment" accorded the "lernaeids" in the systems of previous naturalists, it was probably inevitable that the group would finally and thoroughly be approached from this direction. Indeed, even in our own time, workers in the one field have embraced the other—the best example perhaps being Satyu Yamaguti (1894–1976), an internationally acclaimed helminthologist.

So it was natural for Rudolphi to turn his bright student onto a large collection of parasitic "worms," including a good number of the lamentable lernaeids. The first part of Nordmann's (1832) "Micrographic Contributions to the Natural History of Invertebrates" was published early in the year, since the preface was dated March 1832 and Nordmann listed himself only as "Dr. and Professor, member of several learned societies." He spoke of the second part "already in press." By the time this appeared in late 1832, Nordmann was able to include his affiliation with the Richelieu Lyceum in Odessa. The latest date mentioned in the second part was the 9 July 1832 death of a friend.

Nordmann dedicated the first part to the Imperial Russian Academy of Sciences in St. Petersburg. The second part was dedicated to two influential persons. The first was Robert Rehbinder, Imperial Russian Undersecretary for Finland and the Proconsul of the Alexander University in Helsingfors. Perhaps Nordmann already had his eye on that university, where he spent his last years. Rehbinder shared the dedication with "Prof. Dr. C. G. Ehrenberg in friendly return for repeated instruction" (Nordmann 1832).

His professor and mentor was not forgotten, for Nordmann declared that "I am glad to have this opportunity to express my sincere thanks to Privy Councillor Rudolphi for the support which he bestowed upon my investigations, as much for the free use of his classic collection of helminths as for his excellent library" (Nordmann 1832).

Nordmann (1832) began his account with a quote from Johannes Müller: "Die Wahrheit ist in Gott, uns bleibt das Forschen" ["The truth is in God, for us remains the searching"]. Nordmann said his intent was not to publish a taxonomic treatise, nor to place the parasitic crustaceans in systematic order. Instead, this was "a report on the natural history of parasitic crustaceans, especially of their development, metamorphoses, dissections, and sexual differences with respect to the peculiar lernaeiform animals." However, he pointed out that it was necessary to include descriptions of several new forms. He felt that the descriptions of male lernaeids, a deficiency that baffled Cuvier, and the disparities between sexes were especially noteworthy. He was modest, for the world had seen nothing like his "Micrographic Contributions." Nordmann, citing Suriray (1820) as the first to disclose the metamorphosis of these parasites, said that the similar development of such genera as *Cyclops, Ergasilus, Lernaeopoda, Tracheliastes,* and "other lernaeids" indicates that they are "analogous." This was revolutionary, and copepodology was at that point conclusively and inclusively in focus: "One is startled when first hearing of it; one is amazed when seeing it; one is moved to a peculiar awe of Nature, which cannot be expressed in words, when comprehending as fact what had seemed unbelievable" (Nordmann 1832).



Mikrographische Beiträge

zur

Naturgeschichte der wirbellosen Thiere,

von

Dr. Alexander v. Nordmann,
Professor der Zoologie und Botanik am Lyceum Richelieu zu Odessa,
Mitglied mehrerer gelehrten Gesellschaften.

Zweites Heft.

Mit zehn Kupfertafeln.

Berlin, 1832.
Gedruckt und verlegt
bei G. Reimer.

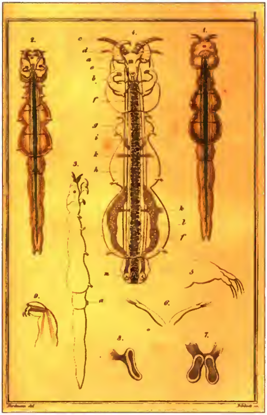
Title page of Nordmann's Mikrographische Beiträge zur Naturgeschichte der wirbellosen Thiere *(1832).*

Nordmann wrote in a straightforward, matter-of-fact style, speaking of the interactions with his colleagues and how his revelations came about. He encountered these copepods as he worked on the parasitic worms in fishes, soon asking himself if he,

> in Berlin and far-removed from the distant seacoast, might not better have disclosed new parasitic entomostracans and new lernaeid creatures, and particularly their development, metamorphosis, and sexual differences, if the same investigations had been undertaken near the sea, where the multitude of fish species would have given more choices and above all their collection would have been easier. . . . (Nordmann 1832)

With these thoughts, Nordmann was forty years ahead of his time; it is a pity that he did not live to see the later flowering of marine stations in the last quarter of his century.

Nordmann (1832) began his "First Proceeding" on the crustaceans with a "Description of some new parasitic entomostracans." Thus, without fanfare, two thousand years of previous uncertainty was swept away: these animals are crustaceans, they are parasites, and they are entomostracans. He titled his "Second Proceeding" the "Contribution to the Natural History of the Lernaeids," although the contents page listed it as the "First Contribution. . . ." This began with a good literature survey; from most of the entries in the survey (which Nordmann marked with asterisks), he had made copies of illustrations to compare with his specimens and discussed the now-familiar positions in which the various authors had placed these animals:



Lamproglena pulchella. *From Nordmann (1832).*

> There is hardly any animal group which from the naturalist's perspective has been treated so shabbily as has the lernaeids. As if the small number of publications about them is not enough, one also finds in most of these only superficial descriptions, in which essentially only the outer form of the species is considered in some measure. (Nordmann 1832)

To Nordmann, what was lacking was detail about the structure of the mouthparts and appendages and about sexual differences. For information concerning the interior structures, he said that the only worthwhile contributions were from Grant and Retzius; for systematics, only from Oken, Cuvier, and de Blainville; and for development, only from Suriray.

Nordmann (1832) reviewed the taxonomic travels of lernaeids starting with "the immortal Linnaeus," who placed them in mollusks, as did others whom we have noted. He interestingly included his acquaintance Blumenbach, who mentioned lernaeids (as Vermes) in his *Handbuch der Naturgeschichte* from 1779 (Agassiz 1848, Baird 1850). Nordmann's (1832) review reached down to "our great, and sadly only recently passed-away Master, Cuvier," who, in spite of all the facts brought out by Suriray, de Blainville, Audouin, and Milne Edwards that should have led him to place lernaeids under the crustaceans, gave them their own unfortunate family within the intestinal worms. Nordmann acknowledged, however, that even armed with Oken and de Blainville, he himself would have been uncertain as to where lernaeids belonged. Nordmann credits several German naturalists, including his friend Arend Friedrich August Wiegmann (1802–1841) and Friedrich Sigismund Leuckart (1794–1843), with the correct assignment of lernaeids to the Crustacea.[3] The elder Leuckart (1827), in a separately published introduction to his "Handbook of Helminthology," said that

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[3] This Leuckart, also a Rudolphi student and later Professor of Zoology at the University of Freiburg im Bresgau, was the uncle of Rudolf Leuckart, soon to be added to our pantheon.

"the anomalous genus *Lernaea* L. probably belongs to the lowest crustacean forms." However, in trying to reconcile these thoughts with the ambiguous de Blainville (1822a), Leuckart (1827) left the lernaeids "between the crustaceans . . . and the trematodes."

Since Nordmann's "Second Proceeding" also contained descriptions of new species, I will review the entire work on a species basis, rather than by the two sections ("Proceedings") as Nordmann arranged it.

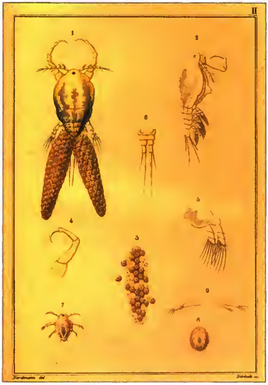
1. a. *Lamproglena pulchella,* a new genus and species assigned to the Entomostraca Poecilopoda of Latreille, was described and illustrated in Nordmann's Plate 1 with much detail on appendages, sizes, colors, method of attachment to fish gills, and comparisons to related species.

b. *Lamproglena lichiae,* a new species from the Red Sea, with a brief description added in a supplement at the end of the work.

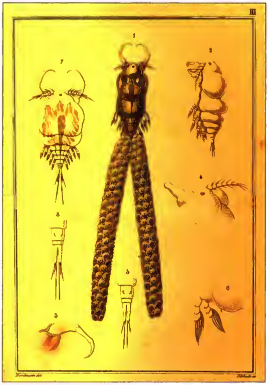
c. *Lamproglena hemprichi,* another new Red Sea species briefly described in the supplement.

2. *Ergasilus,* a new genus, appeared to Nordmann's eye to be a transitional form between the orders Lophyropa and Poecilopoda because of its similarity to *Cyclops,* even though the new parasite was clearly modified for this purpose. Since its species were so common on gills of all the local freshwater fishes, and often in great numbers, Nordmann believed it to be a long-known species, until his "friend Dr. v. Siebold" remarked in the summer of 1830 that this parasite belonged to an undescribed and uninvestigated genus. Nordmann supplied a detailed generic description and compared this with Jurine's and earlier *Cyclops* species. He also compared the seasonal development of *Ergasilus* (including observations of von Siebold) with Ramdohr's notes on *Cyclops* from 1805. Nordmann mentioned the colonies of living protozoans and rotifers often attached to *Ergasilus,* similar to what Roesel had noticed nearly a century before on *Cyclops.* Nordmann recognized that egg development depended upon temperature and related the larval stages to Müller's "nauplius." Three new species were defined:

a. *Ergasilus sieboldi* was named for "Dr. E. v. Siebold, presently applying for [medical] certification in Hei-



Ergasilus sieboldii. *From Nordmann (1832).*



Ergasilus gibbus *(Figs. 1–6) and* Ergasilus trisetaceus *(Figs. 7–8). From Nordmann (1832).*

ligenbeil in East Prussia." Nordmann's Plate 2 illustrated details of the female, the egg sacs, hatching eggs, and a nauplius.

b. *Ergasilus gibbus,* a new species from the gills of *Anguilla,* the common European eel (Kabata 1979). Details of this and the following species were depicted on Nordmann's Plate 3.

c. *Ergasilus trisetaceus,* believed now to be a synonym of *E. sieboldi* (see Kabata 1979).

"Dr. Siebold announced in a letter to my treasured friend Prof. Wiegmann, of this very place, that at first he found a fourth species on our freshwater fish," but Nordmann said he had no knowledge of an additional species (Nordmann 1832). In the supplement at the end of the work, Nordmann added some comments about the geographical distribution of the genus *Ergasilus,* noting especially that it had been found on a Cape of Good Hope (South Africa) fish in the Berlin Museum. Because of their economic importance, *Ergasilus* species have been vigorously studied.

3. *Caligus* received a substantial definition, incorporating descriptions from several earlier authors. Nordmann distributed his new *Caligus* species and other *Caligus* species into two unnamed subgroups. He summarized the caligids with a diagnosis of the genus and of each of his six species:

a. *Caligus bicuspidatus,* a new species, was based on three specimens from Tilesius's worldwide trip that were found in Rudolphi's collection. Unfortunately, there was no information on the host species. Nordmann gave a detailed description, with comparisons to other genera and species. In a supplement, printed on the last pages of the work, Nordmann then regarded this not as a new species, but as the male of Müller's *Caligus curtus.*

b. *Caligus mulleri* Leach.

c. *Caligus elongatus,* a new species, another of Tilesius's specimens in Rudolphi's museum, again with host unrecorded. This species is widespread geographically and among hosts and has therefore been saddled with many synonyms. Kabata (1979) said that it is likely the most common parasitic copepod in British waters.

d. *Caligus minimus* Otto, one specimen from a Red Sea fish in the Berlin Zoological Museum. Nordmann said that there were several undescribed *Caligus* species in this collection, adding that he deposited specimens in the museum for most of the forms he worked with. Indeed, some of this material has been reexamined in recent years.

e. *Caligus diaphanus,* a new species that Nordmann planned to describe more fully in a subsequent publication. He referred to a Plate 11, but his planned publication never materialized and his figures were not published. In any case, this distinctive species has been identified by subsequent workers.

f. *Caligus pharaonis,* a new species, from a Red Sea fish in the Berlin Museum.

4. *Lepeophtheirus,* a new genus for *Lernaea pectoralis* Müller, closely related to *Caligus.*

5. *Binoculus,* a resurrection of an old name as it was used by Otto Fabricius. Nordmann believed that this was a valid genus and that Müller's *Caligus productus* should belong there, a prospect not permitted by today's rules of nomenclature. A second species would be *Binoculus sexsetaceus,* a new species represented by three specimens sent to the museum by Otto. This is now considered the same as Otto's *Caligus heptapus.*

6. *Cecrops latreilli* Leach, recognized by Nordmann as one of the largest parasitic copepods.

7. *Dichelesthium sturionis* Hermann was given a long description, "even though Jean Frédéric Hermann (1804) was careful" (Nordmann 1832). Nordmann compared this to *Nicothoe* Audouin and Milne Edwards and to *Nemesis* Risso, which he believed were closely related.

8. *Epachthes,* a new genus, of which Nordmann (1832) said that he "was very pleased with the discovery of this peculiar form. It is already in transition to the lernaeids, and above all through it I can fill a space in the series of parasitic Crustacea which perhaps otherwise would have to be completed only through the genus *Lernanthropus* de Blainville, which I know of only from his description."

There was a single species, *Epachthes paradoxus,* sent from the Cape of Good Hope "by Apothecary Krebs," along with many fish and other natural objects to the Berlin Museum (Nordmann 1832).[4] This was another species relegated for later, more complete description, although the referenced Plate 12 was never published. The three type specimens were examined later by Burmeister (1835) and more thoroughly by Kabata (1989). It was long believed, though on weak grounds, that *Epachthes* was a synonym of *Lernanthropus*. This was confirmed, and the species is now known as *Lernanthropus paradoxus*. It must be a very rare species; in spite of considerable work in South Africa, this parasitic copepod has never been seen again. The history of these three specimens reflects copepod systematics at its best and is a rewarding story in itself.

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[4] L. Krebs, an apothecary/naturalist, was visited in Cape Town by Chamisso in 1818 (Kratz 1986).

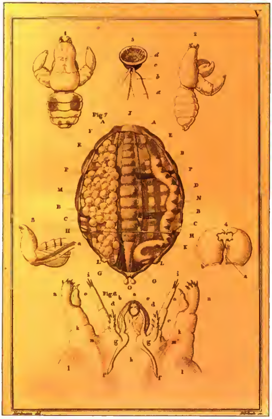
Having brought up *Lernanthropus*, Nordmann here vents his spleen:

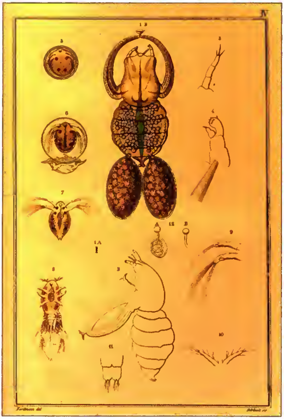
> As is well known, Herr v. Blainville himself gave much trouble with regard to the names of genera belonging to one of the stable families whose memory he invoked to make combinations. . . . Although Hr. v. Blainville perhaps attained his purpose through these acts, it led to the rejection of several earlier and already accepted names. What do these remarkable combinations signify, for example, *Lernaeopoda* or even *Lernanthropus* (from *Lernaea* and [Greek] "anthropus")? In the final regard are these names any better than the inappropriate names of the prolific and industrious author Hr. Lesson, or than the meaningless names created through the transfer of certain vowels and consonants by the otherwise so noteworthy naturalist Leach [listing *Conilera*, etc.] out of C.L.N.R. and A.E.I.O.? (Nordmann 1832)

Nordmann had numerous criticisms of de Blainville throughout his monograph, and this may be the reason there is no mention of any friendship later when Nordmann visited Paris.

A long section followed "On the structure of the feet and jaws of lernaeids." Nordmann (1832) acknowledged some interesting contributions to this from "my friend Dr. Burmeister." The description of new forms continued with

9. *Achtheres percarum,* a new genus and species, defined in a long narrative on the appearance of both sexes, the mouthparts and antennae, the internal structure (including the "vascular system"), and the reproductive parts, propagation, development, and metamorphosis. Although Nordmann





(left) Achtheres percarum. *From Nordmann (1832).*

(right) Achtheres percarum. *From Nordmann (1832).*

noted periods when the males attached to females, his discussion of reproduction and development essentially began with the description of the hatching egg. Lacking only the key mechanism of sperm transfer, described first by von Siebold in 1839, Nordmann's "exceptionally fine" (Brian 1906) account of *Achtheres percarum,* including Plates 4 and 5, made this species the most studied copepod to that time. Nordmann's comments on egg development far surpassed any previous observations, and his discussion incorporated literature from the rapidly expanding field of embryology.

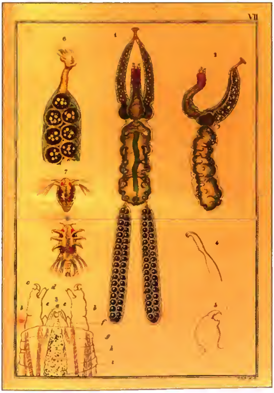
The next pages in Nordmann (1832) dealt with the "first larval stage" and "the larva after the first metamorphosis." He described development up to the first copepodid stage, the only free-swimming stage (Wilson 1911). Nordmann apparently was making observations at the last minute, for he was looking for new stages in May 1832, "even after one year having passed" since the main effort was completed (Nordmann 1832). This exposition on copepod development stood for a generation, until Claus filled in some of the missing sequences.

Ever watching for his primary subject, Nordmann found a tiny worm parasitic in this copepod. I must also note that Nordmann brought parasitic worms into his discussion whenever he could, and the copepod text holds several examples of diversions into that field.

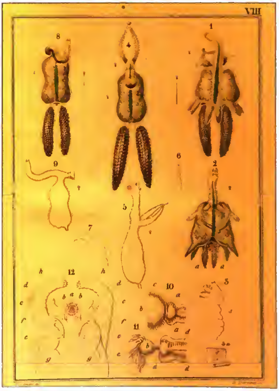
10. *Basanistes huchonis,* a new genus for *Lernaea huchonis* Schrank. Nordmann found ten specimens in "the old Bloch collection [of fish] at the Berlin Museum," on the Danube salmon *Salmo* (now *Hucho) hucho,* and he redescribed the female.

11. a. *Brachiella thynni* Cuvier, another specimen from the museum's collection. Rudolphi had obtained this "from the unfortunate Prof. Schweigger, because of whom, the natural history of lower animals gained so much." Nordmann relinquished a detailed description by referring to Cuvier and moved quickly to three new species:

b. *Brachiella impudica,* the description of both sexes found in codfish gills by another friend. This and the following species, both illustrated on Plate 8, are now in the genus *Neobrachiella* Kabata, 1979. Both are among the oldest type specimens to be recently reexamined and are consequently very well defined (Kabata 1973).



ft) Tracheliastes polycolpus.
m Nordmann (1832).



ght) Brachiella impudica
gs. 1–3), Brachiella bispinosa
gs. 4–7), and Anchorella unci-
ta (= Lernaea uncinata
iller) (Figs. 8–12). From Nord-
nn (1832).

c. *Brachiella bispinosa,* with only the female described.

d. *Brachiella malleus,* found by Rudolphi in 1817 at Rimini, on the Adriatic. (Rimini belonged to the Papal States until 1860, when it was incorporated into Italy.) Nordmann credited this species to Rudolphi, although rules of nomenclature give it Nordmann's authorship. It is now in the genus *Pseudocharopinus* (see Kabata 1979).

12. *Tracheliastes polycolpus,* a new genus and species, based on five live specimens taken by Nordmann from cyprinid fish in November 1831. Nordmann provided a long description of the females and the newly hatched larva and illustrated them on Plate 7.

13. *Lernaeopoda* de Blainville, to which Nordmann assigned Grant's species, *Lernaea elongata.* Rudolphi had received three specimens, including one still attached to a shark's eyeball, from a correspondent. Nordmann provided the description of these females.

14. *Anchorella uncinata,* placing Müller's old *Lernaea uncinata* in Cuvier's new genus. Nordmann and friends, including "Dr. Lovén," found both sexes on various fishes. Nordmann portrayed the female on Plate 8 and again on Plate 10 with the male. This species is now called *Clavella adunca* (Strøm).

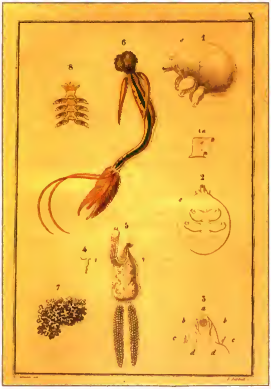
15. *Peniculus fistula,* a new genus and species found on the fish genus *Zeus* by Rudolphi while searching for worms at Naples in 1817. Rudolphi also gave Nordmann his notes on this species, to which he had given the provisional name *Dirhynchus fistula.* Nordmann rejected the manuscript genus name, probably because it had close associations to worms.

Nordmann added that it would be a great advance toward knowledge of these parasites if a naturalist would spend a year at Naples or Rimini. He illustrated the female on Plate 6 and was particularly disappointed in not having males of this form.

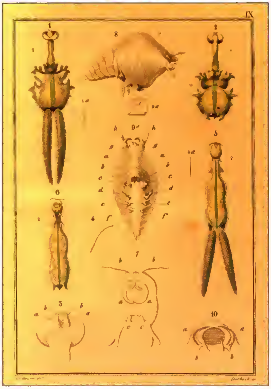
16. a. *Chondracanthus cornutus,* a new combination, placing Müller's *Lernaea cornuta* in Delaroche's genus. Details and illustrations (on Nordmann's Plate 9) were given of both sexes, from the gills of sole. It is now in the genus *Acanthochondria.*

b. *Chondracanthus triglae,* the proper nomenclature, according to Nordmann, of de Blainville's *Lernaeomyzon triglae.* Nordmann described and illustrated the female on his Plate 9.

c. *Chondracanthus tuberculatus,* which includes



(left) Anchorella uncinata *(Figs. 1–5) and* Pennella sagitta *(Figs. 6–8). From Nordmann (1832).*



(right) Chondracanthus triglae *Cuvier (=* Lernaeomyzon triglae *de Blainville) (Figs. 1–4) and* Chondracanthus cornutus *(=* Lernaea cornuta *Müller) (Figs. 5–10). From Nordmann (1832).*

Alexander von Nordmann (1803–1866). From Puzanov (1969). Signature from 4 June 1865 letter to Leiden Museum of Natural History, courtesy of the Nationaal Natuurhistorisch Museum, Leiden.

a good description of the female of this new species.

17. *Pennella sagitta,* in Oken's genus, an old species of *Pennatula* (in part) as defined by Linnaeus, Ellis, and Lamarck. Nordmann pointed to de Blainville's unnecessary synonym, *Lernaeopenna.* The species was illustrated, as graceful as a parasite can be, on Nordmann's Plate 10.

18. a. *Lernaeocera cyprinacea,* the old Linnaean *Lernaea* species in the later de Blainville genus. Here Nordmann made an incredible blunder by not upholding Linnaeus's priority. Everything he had said before this suggested that he would have done so. He did, however, give his usual excellent descriptions of the female and its development, including figures on his Plate 6 (see frontispiece, this volume).

b. *Lernaeocera branchialis,* "a species long-known as Linnaeus's *Lernaea branchialis* and Müller's *Lernaea gadina* and often illustrated in most zoological handbooks."

19. *Bomolochus parvulus,* a new genus and species represented by one specimen from a Red Sea fish. Nordmann gave a long description but said that the figures would await the (never published) continuance of the work. As a result, there was not much confidence in this type species for the genus. Wilson (1911) thought that the second *Bomolochus* species to be described should be the type of the genus, but eventually a species described by Claus took on this role (Kabata 1979).

20. *Lernaeopoda dalmani,* a new combination for *Lernaea dalmani* Retzius.

* * *

Nordmann intended to augment his great copepodological advance and made frequent references to doing so. He already had prepared at least two plates for publication, and these may yet come to light, but they were not published by Nordmann. In particular he mentioned twice as many undescribed *Caligus* species and information on their development. The continuation of the "Micrographic Contributions," he said, depended upon the reception of the first parts among naturalists and publishers. The publisher of this monograph, G. Reimer of Berlin, gave Nordmann a substantial honorarium. I believe that even Nordmann would have admitted that this reception was gratifying, but other events interfered with the continuation of his copepod work.

Nordmann basically laid aside his copepods for equally important endeavors, and he should not be criticized too severely for doing so. He did, however, speak on parasitic crustaceans at the May 1855 meeting of the Finnish Science Society. That he reserved a place in his heart and mind for copepods is clear from his second copepod contribution, thirty-two years after the first, at the end of his life.

At the end of his student days, Nordmann planned to publish a "Synopsis Avium" with Burmeister and Lovén, but a severe outbreak of cholera in Berlin in 1832 drove Nordmann away, and the bird synopsis did not materialize.[5]

By this time, Nordmann had gained a reputation as an independent naturalist, and he was appointed Professor of Botany and Zoology at the Richelieu

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[5] Interestingly, cholera was so widespread that it had closed the University of Helsingfors in 1831 (Saalas 1956), where Nordmann was to hold his last position.

Lyceum in Odessa. Odessa, in southern Ukraine, is on the northwest shore of the Black Sea. It had been under Russian control since 1789, so that his new position required Nordmann to make botanical, zoological, paleontological, and comparative anatomical reports in the Russian language.

The Richelieu Lyceum had been established in 1817 in memory of Armand Emmanuel du Plessis, Duc de Richelieu (1766–1822), who left France to serve in the Russian army against Napoleon. Richelieu had a profound interest in the history of southern Russia and in Odessa's development. The Richelieu Lyceum had already attracted other promising foreigners as instructors, and its students came from many lands. The common language in cosmopolitan Odessa at that time was Italian. The whole atmosphere accentuated Nordmann's already confused feelings of nationality. One great Odessa advantage, for Nordmann, was his meeting another Finnish expatriate, the botanist/entomologist Christian Steven (1781–1863). This was the strongest professional attachment of Nordmann's life, and the two men remained close in friendship and in science (Nordmann 1865). Christian Steven had been a friend of de Candolle, Cuvier, Humboldt, Antoine Laurent de Jussieu, Lamarck, Pallas, and Schrank.

At the end of 1833, in addition to his professorship, Nordmann was named director of both the botanical garden, where he was given living quarters, and the school of horticulture near Odessa. The moderate climate was eminently suitable for a large variety of trees. He kept this position until he left Odessa.

As a teacher, Nordmann was known for his complete and easy presentation of facts, although his first devotion was to discoveries in the field. His association with academic institutions provided the financial freedom to indulge his quests and to publish his findings. The Black Sea attracted numerous scientists to Odessa, and Nordmann met and cooperated with many of them. This encouraged his own travel, or perhaps gave him the excuse he needed to accompany his associates. His extensive journeys to collect flora and fauna included Bessarabia (the territory to the west of Odessa, Russian since 1812), the Danube region, the Crimea, and the Caucasus. Paleontological studies occupied him more and more, especially during his last years in Odessa and again near the end of his life.

In 1834, Nordmann married his cousin Anna Helena Blanc, daughter of a jeweler and Anna Nordmann. They had one son, Arthur Frederik, who met a tragic end in the service of science; Arthur left an infant son. The Nordmanns also had three daughters, Marie Anna, Alina (who died in 1857), and Mathilda Amalie.

Alexander von Nordmann (center) with Carl Gustav Mannerheim (left) and the Russian naturalist Karl Eduard Eichwald (1795–1876). From Puzanov (1969).

Possibly Nordmann's most important trip was to the Caucasus in 1835, sponsored by the Academy of Sciences in St. Petersburg. Nordmann collected fishes in Sevastopol Bay and then traversed the east coast of the Black Sea, a dangerous journey because of poor climate, infamous fevers, and a hostile population. Nordmann recalled that he collected with one hand while holding his firearm in the other. This was a large and virgin area for a European scientist, and Nordmann harvested important collections of plants, seeds, mollusks, insects, fishes, birds, and mammals.

Much of southern Russia was being explored in 1837 by Anatoli Nikolaevich Demidoff (1813–1870), traveler and philanthropist, with an entourage of a dozen French scientists. Odessa was their base, and they were fortunate to incorporate Nordmann's experience and knowledge. Czar Nicholas ordered Nordmann to go to Paris to help consolidate the expedition's records. On his way in 1838, Nordmann stopped in Vienna to study fish at the Zoological Museum. He then visited with Oken in Zurich and made the acquaintance of Louis Agassiz, already with a strong European reputation, in Neuchatel.

Nordmann was in Paris from November 1838 until October 1839, supervising the natural history contributions, the *Observations sur la fauna pontique,* for Demidoff's expedition. Nordmann himself worked on the fishes and polyps. Demidoff had spared no expense in either people or equipment, and Nordmann was in the company of the foremost naturalists of Paris. Of most value to him were his contacts with Henri Milne Edwards and the ichthyologist Achille Valenciennes (1794–1865).

In the summer of 1839, Nordmann and his new friend Milne Edwards studied marine invertebrates along the Normandy coast—much to Nordmann's pleasure, for these were infinitely more diverse than those from the Black Sea.

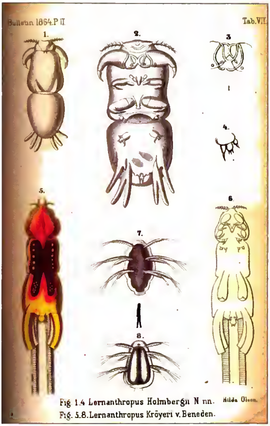
Nordmann knew more about the natural history of southern Russia than even the few native naturalists. He had explored the mountains of Taurien (east of the Crimea); the deep, calm waters of Balaklava and Sevastopol; the wild flowers of the steppes; Kiev's forests; Bessarabia's marshes; and the Danube Valley. He had made altogether ten trips to the Crimea, on one of which (in 1833) he was accompanied by the zoologist/copepodologist Martin Heinrich Rathke. The most famous of Nordmann's discoveries there were the fossils brought out in two years of field work, resulting in the comprehensive "Paleontology of South Russia," published from 1858 to 1861. I noted that he prudently did not travel there during the Crimean War (1854–1856), although he received frequent news from Steven's front-row seat (Nordmann 1865).

Cholera again forced Nordmann to make a significant change. His wife died of this disease in 1848, and Nordmann decided to return to his homeland even though he had strong attractions to his Odessa positions. On his departure, he received a pension from the horticultural school. The Chair of Natural History had become vacant at the Alexander University in Helsingfors (Helsinki), since 1812 the capital of Finland. (The academic center of Finnish natural history, the zoological museum, and Sahlberg as well had recently moved there from Åbo.) Nordmann applied and, after a successful post-closing appeal (citing the great distance and difficulties in correspondence), was given the professorship in April 1849. This chair was divided into the Professor of Botany and Professor of Zoology in 1852, when Nordmann retained the latter.

Nordmann noted a widespread Finnish national awareness that had not been present when he left in 1827. This was attended by a pervasive materialism, disturbing to Nordmann. No longer a young man, he found it difficult to adjust. He was unpopular with the new men in the Society for the Fauna and Flora of Finland, which he had helped create. When Nordmann returned to the society he became chairman, but his proposals to use some society funds for an expedition to the White Sea were violently opposed by others who saw fiscal carelessness as well as patriotic dangers in extending studies beyond Finland's borders. Because of this dissension, Nordmann and other eminent members resigned their leadership roles in 1849. Among those who resigned were the president of the Finnish Science Society, entomologist Count Carl Gustav Mannerheim (1797–1854), and its chief director Nils Gustav Nordenskiold (1792–1866), geologist and father of the Arctic explorer Adolf Etic Nordenskiold (1832–1901). Nordmann emphasized that since he was a founding member his resignation was not a trivial decision, but he felt strongly that the society was not fully promoting biological science by limiting its studies to Finland's borders. It was not until eleven years later that "at last this prolonged schism was settled" (Elfving 1921). Nordmann again worked with the society toward the advancement of natural history, with even closer ties among the society and the university and its museum.

Nordmann's successor at the university (appointed in 1867) was one of his students, entomologist Fredrick Wilhelm Maklin (1821–1883). Maklin had also been among those who resigned from the society in 1849, but he never again worked well with the society. In November 1871, for the society's fifty-year all-day celebration, the three surviving charter members were guests of honor. In the place of Alexander von Nordmann was his brother, an admiral, "who gave a cheerful and detailed description of the period and how Nordmann became a member of the Society" (Elfving 1921).

Nordmann had become a member of the Finnish Science Society in 1840 and upon his return took an active part. He attended most meetings and often contributed something new. He was chairman in 1851 and 1852. He was remembered there as a kind man with humane manners and helpful to everyone. He never slandered or worked against another. He was an observer with a sharp and critical eye whose good nature sometimes kept him in doubt of his own abilities. Anyone who had an interest in his science was certain to receive a hearty welcome and a warm hand from him.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Tab.VII.
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Fig 1.4 Lernanthropus Holmbergii N nn.
Fig. 5.8. Lernanthropus Kröyeri v. Beneden.
Hilda Olsen.

Lernanthropus holmbergi *(Figs. 1–4) and* L. krøyeri *(Figs. 5–8). From Nordmann (1864).*

In 1850, Nordmann toured many European cities. He spent time in Stockholm, Uppsala, Göteborg (visiting with his friend Lovén), Copenhagen, Brussels, Paris, and London, returning by way of St. Petersburg.

Nordmann considered his greatest scientific distinction his 1852 election as a corresponding member in the zoological section of the French Academy of Sciences, replacing Ehrenberg who was named an associate. Some others important to our narrative were likewise honored at the same time: C. J. Temminck (Leiden), D. F. Eschricht (Copenhagen), Michael Sars (Christiania), and P. J. van Beneden (Louvain). This distinction was reiterated in 1860 when some additional men important to our story were also enrolled: M. H. Rathke (Königsberg), J. E. Purkinje (Prague), J. D. Dana (New Haven), and C. Th. von Siebold (Munich).

Travel to Berlin in 1858 found Nordmann with a number of "young naturalists interested in lower animals" (Hjelt 1871); these naturalists were regretfully not recorded. From Berlin, Nordmann went to Munich and then to Paris, where he reported his highly praised paleontological work to the Academy of Sciences. Afterward he attended a naturalists' meeting in Karlsruhe, where he met his friends Kölliker, then at Leipzig, and van Beneden.

At this time, Nordmann also promoted the university's zoological museum, and he was instrumental in increasing its staff and collections and in improving its administration. He recognized from his experience with Rudolphi's helminths the value of collections and their proper keeping. On a final trip to the Crimea, he visited in Halle with Professor Burmeister, recently returned from Brazil. He also stopped in Vienna to examine collections from the *Novara* Expedition. Nordmann spent the winter of 1860–1861 in the Crimea, arranging some previous collections for the museum. He found that Odessa was not as he had left it. His botanical garden had been destroyed for commercial development, and the horticultural school had been moved out of the region. He returned to Helsingfors dispirited and suffering from heart ailments, signs of which had already plagued him.

Nordmann received a severe emotional blow when his son died. Arthur Nordmann was his father's copy, just beginning a promising career in natural history with the same love of field work and scientific discovery. In the fall of 1857, Arthur accompanied Admiral Kuznetsov's expedition to the Amur region and sent home rich collections. Arthur published several short papers on this material in the bulletin of the Imperial Society of Naturalists of Moscow. In 1861, he joined his father in the Crimea and then left for another expedition into eastern Siberia. On this trip, in 1862, Arthur was murdered by knife-wielding bandits in remote Nerchinsk. His father never recovered from this crushing news.

In 1862, Nordmann and his two surviving daughters went to Berlin to see Ehrenberg. He then went to Switzerland, Italy, and Paris, returning by way of Berlin and St. Petersburg.

Among Nordmann's last studies was his second and final publication on parasitic copepods, in 1864. Many names, both copepods and copepodologists, were introduced in the generation between Nordmann's two copepod contributions. In spite of our now passing over a considerable history, I believe that it is best to include the 1864 publication in this chapter. Nordmann's "New contribution to the knowledge of parasitic copepods" is the first paper encountered in our chronology that used "copepod" in the title, although we have momentarily skirted some others that did so before this time. Nordmann titled this work the "First Contribution," although this, like the 1832 contribution, never saw a sequel. Nordmann had thirty years of catching up to do:

> Because I possess a comprehensive collection of parasitic crustaceans, preserved in about 130 alcohol jars, and which in part I myself collected over several years, or had received from various friends, such as J. Müller, Milne Edwards, Lovén, Kollar, Krøyer, Malm, Malmgren, and my only, unfortunately recently deceased son, Arthur, it is my intention to publish little by little descriptions of the new and less closely investigated species and variations.[6] Already in 1840 I had promised Milne Edwards to treat this interesting group with a special effort as [the] continuation of my "Micrographic Contributions to the Natural History of Invertebrates" [that had been] so favorably received. However, pursuit in other directions of natural history, a busy life passed with much traveling, and my previous domicile Odessa and southern Russia which in general was not well suited to provide the necessary material, were the reasons that the intended study was not accomplished until now.
>
> Regarding the parasitic crustaceans, with which I had been much employed more than 30 years before, since then the cited literature has expanded and several excellent naturalists have begun precise investigations. (Nordmann 1864)

For the older literature, Nordmann referred the reader to Milne Edwards and, in the interest of time, said that he omitted a full review of recent papers, listing and annotating only the principal works that had come to his attention. Nonetheless, it was a credible dozen-page performance, and he included all the significant authors. He referred to an "excellent publication [of Claus], in which the old forerunner Nordmann is repeatedly enlightened, and to this I will respond" (Nordmann 1864). Nordmann was feeling his age and watching a field move away from him; thirty years was too much time to make up: "When one has a new object before him, he describes it as well as possible, gives it a name, and then 'lets it run away,' and, at best, consoles himself that a younger successor may find it again and be able to investigate it more thoroughly" (Nordmann 1864). When it was all new, it was easier. Still, Nordmann knew the relevant literature, and his descriptions were contemporary. Of Nordmann's four plates, the first was drawn by his oldest daughter, Marie, the next two by a Hilda Olson, and the last, somewhat more animated, apparently by Nordmann himself.

Nordmann (1864) followed some then-recent workers who perhaps gave too much weight to egg-sac structure (filiform vs. saccular) in grouping parasitic copepods. As in other systems based on superficial characteristics, this in some cases placed unrelated genera side by side. The bulk of this paper is a series of descriptions and illustrations for mainly new genera or species:

1. *Strabax monstrosus,* new genus and species, based on the "pygmy male" and female received from "the late Professor F. S. Leuckart in Freiburg" in 1839.
2. *Pseudulus lingualis,* new genus and species, with an illustration of one damaged female from the tongue of a codfish. It is a phantom species, not seen since; perhaps it is a pennellid (Kabata 1979).
3. *Pennella sultana,* new species, and a new variety *sigmoida.* Nordmann found this in the collections of the "Zoological Museum in the Botanical Garden" of Paris in 1839.
4. *Norion expansus,* new genus and species; *Norion* is now held as one of five lernanthropid genera (Kabata 1979). One of Nordmann's friends, the geologist, ethnographer, and Inspector for Fish Culture, Heinrich Johan Holmberg (1818–1864) (Jarvi 1942), found this copepod on an unknown fish in Hawaii. For this and most of the following species, Nordmann attached a brief Latin description.
5. *Tucca impressus* Krøyer, 1837, with a redescription of the type species of this poecilostome genus, now the type of the family Tuccidae Vervoort, 1962. Krøyer's single specimen had come from the Danish West Indies, while Nordmann found ten specimens from West Africa in the Hamburg museum in 1858.
6. *Donusa clymenicola,* new genus and species, parasitic on an annelid worm collected on Sweden's west coast by Lovén. Nordmann's description added to

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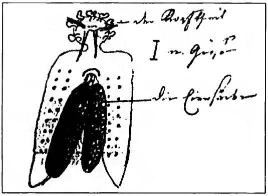
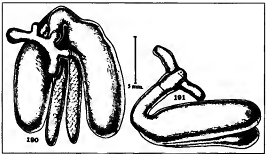
[6] Johannes Müller has already been mentioned. Anders Johan Malmgren (1834–1897) was Nordmann's student; he was a member of a Swedish expedition to Spitzbergen in 1861 (and also later), and he may have brought back copepods. He became a Professor of Zoology, a fisheries inspector, and a provincial governor (Elfving 1921, Jarvi 1942). The other Nordmann friends were copepodologists and will be discussed in turn.





Copepod sketched by Nordmann in 4 June 1865 letter to Leiden Museum of Natural History (left), compared with Lernaeosolea lycodis *Wilson, 1944, from a wolf-fish off New Jersey (Wilson 1944). Suggested by Z. Kabata in personal communication.*

work on these forms by Steenstrup and Lütken, Michael Sars, and Krøyer.

7. *Lernanthropus* de Blainville, with a long description of the genus and a summary of its seven species from literature. Nordmann added two new species and new information on an older species:

a. *Lernanthropus temmincki,* from an East Indies fish sent to Nordmann's university museum by Coenraad Jacob Temminck (1778–1858), the first director of the Leiden Museum of Natural History (Holthuis 1995).

b. *Lernanthropus holmbergi,* another specimen from an unknown fish in Hawaii. Figures 1–4 are reproduced here; the small scale between Figures 3 and 4 indicates the natural size of the male.

c. *Lernanthropus kroyeri* P. J. van Beneden, 1851. Figures 5–8 are reproduced here. Figure 5, in color, was first drawn from life in 1839 near St. Vaast on the Normandy coast. Figures 7 and 8 are of nauplii, and the sketch between them shows the natural size of the adult female. Wilson (1922) thought that this was not van Beneden's species, and he renamed it after Nordmann.

8. *Stalagmus petersi* (P. J. van Beneden, 1857), a new genus for a species first described in the genus *Lernanthropus.* Today it is believed to be a junior synonym (Kabata 1979).

9. *Peniculus,* with new information but no illustrations on Nordmann's species from 1832, and a new species:

a. *Peniculus fistula,* a few lines only.

b. *Peniculus calamus,* new species, described from another specimen that Holmberg brought from Hawaii, although now Nordmann indicated that his friend was ill and bedridden, while a footnote reported that he had died.

Nordmann (1832) dedicated this work in honor of a great colleague, and it was "preliminarily concluded on the day of the Jubilee for our Nestor of Embryology, K. E. v. Baer, 29 August 1864," marking von Baer's fiftieth anniversary of earning his M.D. from the University of Dorpat (its German name; now Estonian Tartu).

An international flower exposition was held in Amsterdam in April 1865, and Nordmann was invited to be a judge. This event attracted naturalists from near and far. Nordmann added a trip to Leiden, where he had a good visit with Hermann Schlegel (1804–1884), director of the Museum of Natural History, and Jan van der Hoeven (1801–1868), who by that time had published three papers on parasitic copepods. Nordmann examined fishes and their parasites collected by Pieter Bleeker (1819–1878) in East Indian seas. In Hamburg afterward, he admired the zoological garden and the aquarium and sent a letter to Schlegel, his Leiden host:

> Hamburg, 4th June 1865
>
> Most esteemed Herr Colleague,
>
> Now, after we have reached Hamburg and in some days will be returning home via Luebeck, I regret that we did not stay with you in Leyden longer than we did. I was fairly well there and would certainly have been able to find several more, interesting parasitic crustaceans in the great mass of not yet studied fishes. However, an eczema, which had bothered me for two consecutive winters, made me go to Aachen . . . in order to place myself in a warm water cure. Upon advice, I chose the warmest springs in middle-Europe, the sulfur spa at Burtscheid where I drank 60 [degree] mineral water, transpired dreadfully in the high air temperature, got a cold in spite of all the precaution, and now have been rheumatic . . . for 5 weeks very ailing. In Aachen, where

> the use of mineral water apparently has been harmful to me [Burtscheid apparently was already regarded as a suburb of Aachen], one of my doctors wanted to send me to Ems [i.e., Bad Ems, east of Koblenz] and another one to Ems, Wildbach, Ischl [Bad Ischl, east of Salzburg] and God knows where else, but I have preferred to go home.
>
> They have shown us so much compassion and kindness for which we will be forever grateful, and you can easily imagine the lamentations with which both my daughters accompanied my desolate state of health!
>
> Aachen, as you know, is not a scholarly town, Dr. Debey [Dabey?], I. [J.?] Mueller, and Dr. Beissel are geologists, Prof. Foerster is an entomologist. I have met these gentlemen, but because of my illness I did not see their collections. Dr. Beissel told me that a paper of his is supposed to be printed in Leyden. B. draws the polythalmi . . . very splendidly and is an amiable man, who at times visited me. The remarks by Fritz Mueller "For Darwin" I found especially interesting. The specimen in question from the paleontology of the Southcoast . . . I have given to Count Sieverr in Haag, asking him to present it to any gymnasium. Probably it is in the library of the university in Leyden. Shortly before leaving Leyden, through "Heinrich" in the Hotel of the Golden Lion, I sent two volumes of the biography . . . , one for you, the other one for Mr. van Voltenhofen. In case you did not receive the brochures, do reclaim them from Heinrich. I have found about 26 new forms of parasitic copepods on Bleeker's fishes, and among them was a quite curious creature (on the head of a cottus), which I already meant to throw away in Leyden, for it looked like a skin fold, with which the fish's body is amply provided. In Burtscheid I investigated the miraculum more carefully and found to my delight that it *is* a copepod and looks about like so [diagram follows]:
>
> ....the headpart
> ....[**scale**] natural size
> ....the egg sacs
>
> Regrettably, there was no specific label with the fish, and perhaps the kind Mr. v. Bemmelen could write me how the eggmass-adorned cottus-species is named in Bleeker's listing?
>
> For 4 days now we have been in Hamburg; the zoological garden, and the aquarium that is so much talked about, and Dr. Brehm. I still hope to be able to visit, but so far, in my exhausted state of health I could not do it. I ask [you] to give best greetings to all the gentlemen in your wonderful zoological museum. My girls ask to be remembered and thank you and your dear family. If I regain my strength, I will write from Helsingfors.
>
> Keep in friendly memory your friend and servant, who much esteems you,
>
> A. Nordmann

Nordmann felt that this was his last foreign travel, and he visited many of the friends from his youth, reflecting on a busy life covering several subjects.

Nordmann was no stranger to honors in his time: a jeweled ring from the czar (1836), a Knight of the Order of St. Anne (1839, 1847, and 1856, various degrees of knighthood), a silver medal at the Odessa Agricultural Exposition (1843), the Order of Vladimir (1844 and 1866), a grant from the czar and the Imperial Academy of Sciences in St. Petersburg to continue his paleontological work (1847), a royal order from the Turkish sultan (1849), and an appointment as senator to the royal court (1861).

Nordmann was a member of many scientific societies, including the Société Philomatique in Paris (from 1838) and the august Academia Naturae Curiosorum (from 1851), where he took the fraternal name Rudolphi, after his late professor.

In light of his worsening health, Nordmann was asked to relinquish his professorship, and he did so in February 1866. Nordmann died of heart failure on 25 June 1866. Living memories of Nordmann were inevitably lost, but his published record includes one of copepodology's majestic memorials, which, with Nordmann's many other notable accomplishments, ensures his eternal recognition and honor.

In the list of Nordmann's sixty-one publications (Hjelt 1871), seven are considered major works, including the section on Entozoa for the 1840 second edition of Lamarck's *Histoire naturelle des animaux sans vertebres,* edited by Milne Edwards. Most of Nordmann's publications were in French or German, and many were translated and republished. Nordmann left his extensive collections and a large sum of money to the Royal Alexander University of Finland.

There are many species of plants and animals that commemorate Nordmann's name. Among these are the copepods *Lepeophtheirus nordmanni* (Milne Edwards, 1840); *Euryphorus nordmanni* Milne Edwards, 1840; *Salmincola nordmanni* (Kessler, 1868); and *Lernanthropus nordmanni* Wilson, 1922. The quintessential marine cladoceran, *Evadne nordmanni,* was named by Nordmann's friend from university days, Sven Lovén. Nordmann's lifelong botanist friend, Steven, named a stately evergreen tree *Pinus nordmanniana. Pinus* was an inclusive Linnaean genus, afterward broken into many conifer genera; *nordmanniana* is the well known Nordmann fir, *Abies nordmanniana,* from the Caucasus, Asia Minor, and Greece, and now living in large gardens throughout the world, including the arboretum at my own home.

TRANSITION

> When I find a well-drawn character in fiction or biography, I generally take a warm personal interest in him, for the reason that I have known him before—met him on the river.
>
> —Mark Twain, *Life on the Mississippi*

AT THE BEGINNING of Chapter 3, I quoted a careless assumption that the study of the insect-like animals was "an activity for men and women of quiet, modest, and totally undramatic character." In reassessing the nearly one hundred men who studied copepods from Aristotle until von Nordmann, I find no one who would fit this description, when adequate biographical material is available. I do not yet have the keys to unlock the biographies of Barbut or Ramdohr—perhaps they were so "undramatic" that their life's records died with them. The failings, however, are likely mine, not theirs. I will continue to search however and wherever I can.

As for women in our field, this long early period was not favorable for their participation. Women in the natural sciences were rare until the end of the nineteenth century. The first lady copepodologist, to my present awareness, was Edith Mary Pratt (1898), followed closely by Alice L. Embleton (1901), Esther Fussell Byrnes (1903), and Rina Monti (1904) (see Vervoort 1986a,b). Since that time, women have made numerous and significant contributions, as evidenced in the works of Maria Dahl, Marie V. Lebour, and many others to date. I know of six father/son copepodology teams—P. J. and Edouard (1845–1910) van Beneden, Oronzo Gabriele (1787–1867) and Achille (1818–1898) Costa, Stephen Alfred (1844–1930) and Ernest Browning (1876–1966) Forbes, Johann and Jean Frédéric Hermann, Michael and G. O. Sars, and Thomas (1840–1929) and Andrew (1868–1931) Scott—but Rina Monti (1871–1937) and her daughter Emilia Stella (1909–1994) were the only mother/daughter copepodology duo. I am also pleased to record a father/daughter combination: Mikhail M. Kozhov and Olga M. Kozhova.

For copepodology, the crucial and defining works in the seventy-four years after Linnaeus's *Systema Naturae* were Müller's *Entomostraca*, Lamarck's and Latreille's works moving the copepods from the insects to the new Class Crustacea, Suriray's neglected revelation of the metamorphosis of parasitic copepods and their relationship to the free-living species, Jurine's wonderful exposition of freshwater copepods, de Blainville's monograph on lernaeids, and Nordmann's *Mikrographische Beiträge*. This last, from 1832, salvaged Suriray's forgotten insights and proved without a doubt the crustacean affinities of the parasitic copepods.

Alongside the landmark publications of this three-quarter century were many commentaries on and contributions to the details and breadth of our science, especially in regard to the parasitic forms. These have been summarized above (Chapters 8–9, 11–12, and 14). To avoid fragmentation of biographies, I have also recorded several genera and species not described until after 1832. To now tally the ever-increasing catalog of new taxa would not, I believe, be especially useful.

If I were asked who among these men I would wish to speak with, I would answer with only a little hesitation that I would want most to interview J. C. Fabricius, in particular because of his intimacy with Linnaeus, Lamarck, and Latreille. However, as long as "thought is warm, and fancy flows" (Cowper 1792), I would also want to converse with Lesueur because of his friendship with Suriray, Risso, Desmarest, and Say, and his acquaintance with Bory de St. Vincent and André Michaux.

This history of the study of copepods will start in Volume 2 in the 1830s, a memorable decade because it began with the introduction of the "Ordre des Copepodes" by Milne Edwards (1830). Although the group collectively is now considered under the name "copepod," Milne Edwards used the term only for the free-living species. He held the parasitic forms separately, and somewhat remotely, in the order "Siphonostomes" in a classification based on mouth parts, characteristics that are still meaningful. Even though this was significant progress, showing that all of these species were crustaceans, the free-living and parasitic copepods would not be integrated until the passage of another generation. Therefore, the 1830s began with copepods and siphonostomes at taxonomic levels equal to the ostracods, cladocerans, amphipods, isopods, and other orders of the "lower Crustacea," just as the broader copepods are in today's classification.

Milne Edwards offered another copepodological high point in 1840, within the third volume of his classic *Histoire Naturelle des Crustacés,* summarizing copepod knowledge as well as providing new views on anatomy, physiology, and classification (Milne Edwards 1834, 1837, 1840; Holthuis 1979).

By the early nineteenth century, copepods were no longer an academic novelty. With their place in nature revealed, they became a necessary part of aquatic investigations. A large step in world coverage occurred with the U.S. Exploring Expedition (1838–1842) and its remarkable participant James Dwight Dana. Dana also introduced new classifications, although these were more reminiscent of the preceding (post-Linnaean) period. However, Dana was the first to look at copepods with a nearly worldwide view.

Baird's charming monograph of British Entomostraca, mentioned many times for his coverage of the earliest literature, adapted the better parts of Latreille's and Milne Edwards's systems. In the mid-nineteenth century, copepod work, as in other branches of natural history, began to occupy more time per individual, in a period where "amateurs" tended to be replaced by professionals. The generally strong economies began to accept biology as useful, especially in regard to medical and agricultural applications.

Carl Claus (1835–1899) was a brilliant representative of the new professionalism, dipping his pen into every carcinological well. He greatly simplified classification and incorporated new morphological standards.

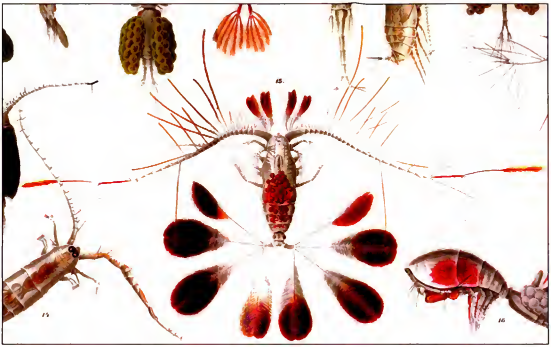
The two main copepod groups steadily advanced in closeness through the 1850s until their definitive integration by Tord Tamerlan Teodor Thorell (1830–1901), who recognized the affinity of the free-living and parasitic forms. His classification was also based on mouth parts.

In the post-1859 Darwinian era, greater emphasis was given to the naturalness of classifications; this continues to be improved upon. Copepods were then examined with evolution in mind, searching for ancestors and missing links in series of species and varieties. Advances in all zoological fields gave ample comparative material, while advances in chemistry and physics gave fresh technology to apply to life sciences, especially physiology and developmental biology. In addition, there were better microscopes and related techniques.

George Stewardson Brady (1832–1921) refined Thorell's system and added geographical coverage through reports on the *Challenger* copepods and other far-flung collections, a harvest of many major national expeditions in the last quarter of the century.

I anticipate that the next installment of this history will end near the period dominated by Eugene Canu (1864–1952), Wilhelm Giesbrecht (1854–1913), and G. O. Sars in a Golden Age of Copepod Morphology, with the origins of the essential classification of today.

Among these outstanding efforts in the advance of copepod science are the lives and contributions of many influential copepodologists, some of whom have been introduced in this volume: P. J. van Beneden, Axel Jonas Boeck (1833–1873), Hermann Burmeister (1807–1892), Sebastian Fischer (1806–1871), George Johnston (1797–1855), Vincenz Kollar (1797–1860), Henrik Nikolai Krøyer (1799–1870), Rudolf Leuckart, Wilhelm Lilljeborg (1816–1908), Sven Lovén, John Lubbock (1834–1913), August Wilhelm Malm (1821–1882), Alfred Merle Norman (1831–1918), Rudolph Amandus Philippi (1808–1904), Michael Sars, Carl von Siebold, Japetus



Calocalanus pavo ***(Dana, 1849), one of the most frequently copied copepods in later years. From Giesbrecht (1892).***

Steenstrup, John Obadiah Westwood (1805–1893), and many interesting persons whose contributions to this field were relatively minor.

* * *

The agreed-upon formal structure that evolved from Linnaeus's labor connects all copepod workers and works that have followed. Far from being obsolete, the older publications are prerequisite to careful taxonomic research. Indeed, the beauty, precision, and value of many of these contributions have never been surpassed. Like our predecessors, we will leave connections to an unknowable future. The System of Nature and its consequences have joined us all in a resolute community with no boundary of nation or time. That is our heritage and our theme.

Some names stand out, but all owed something to others; every lesser name added a stone to a worthy monument. Even so, for all the men and matters that have gone before, we still do not have perfect vision of the bright specks that tease and elude us behind their watery curtain.

> Remember me in a particular manner to Dr. Solander. How happy I should be in having an hour or two's tete-a-tete with you both! If seas and mountains can keep us asunder here, yet surely the Father of Wisdom and Science will take away that veil and these obstacles when this curtain of mortality drops; and probably I may find myself on the skirts of a meadow, where Linnaeus is explaining the wonders of a new world to legions of white candid spirits, glorifying their Maker for the amazing enlargement of their mental faculties. What think you of this time, my dear friend? Shall we have a hearty shake of the hand if such practises be fashionable or in the mode? Believe me, I long to see more of my God, and to know many of my friends that I am afraid I cannot meet elsewhere.
>
> —Alexander Garden, *Letter to Carl Linnaeus,* 1761

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Yours respectfully
Carl W. S. Aurivillius

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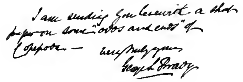

I am sending you herewith a short paper on some "odds and ends" of Copepoda — very truly yours
George S. Brady

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Yours very sincerely
Möbius
Director of the zoological
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Yours very truly
A. M. Norman

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Yours very truly
Dr. R. A. Philippi, director
of the Museo Nacional.

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Believe me, dear Master,
yours respectfully.

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Yours sincerely
Andrew Scott

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Yours very truly,

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From his youth on the Oregon coast, David Damkaer has been interested in the oceans, their inhabitants, and their history. He holds a B.S. and M.S. in oceanography from the University of Washington-Seattle, and a Ph.D. in zoology from George Washington University. From 1965 to 1973, Damkaer worked with invertebrate collections at the Smithsonian Institution, a position that necessitated travel throughout the world.

He returned to Seattle to work with the National Oceanic and Atmospheric Administration, retiring in 1994 as deputy director of the largest research division in the National Marine Fisheries Service. During much of that time, he was an affiliate associate professor in the School of Oceanography at the University of Washington.

Dr. Damkaer has authored or co-authored more than 40 papers on copepods and aquatic biology, ten of which took a historical approach. During his career, he assembled a world-class library of copepod publications, containing over 8,000 titles which were indispensable in writing and documenting the present work.

In recognition of his own work on copepods, his colleagues have named after him two species—*damkaeri*—as well as a genus of deep-sea copepod *Damkaeria*. He lives on Cocker Creek, a wildlife refuge and arboretum near Monroe, Washington.

MEMOIRS OF THE
AMERICAN PHILOSOPHICAL SOCIETY
VOLUME 240

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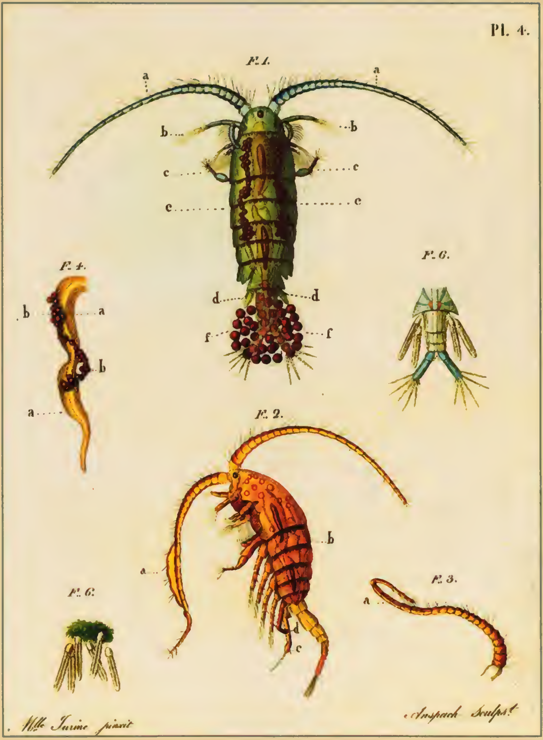
Microscope from Deutsche Bundespost 1981
and digital rendering by Daniel Swanson



Monoculus castor. From Jurine (1820).

ISBN 0-87169-240-6
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